

---

Bell Ringer: Graphical Vector Addition – ID:  
13328

Time required  
15 minutes

---

Topic: Fundamentals

- *Graphically calculate the resultant of two or more vectors.*

Activity Overview

*In this activity, students will graphically add perpendicular vectors and determine the resultant net vector.*

---

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

*Before carrying out this activity, review with students the differences between scalars and vectors.*

- *The screenshots on pages 2–4 demonstrate expected student results. Refer to the screenshots on page 5 for a preview of the student TI-Nspire document (.tns file). The solution .tns file contains sample responses to the questions posed in the student .tns file.*
- ***To download the student .tns file and solution .tns file, go to [education.ti.com/exchange](http://education.ti.com/exchange) and enter “13328” in the search box.***
- *This activity is related to activity 8876: Two-Dimensional Motion and Vectors. If you wish, you may extend this bell-ringer activity with the longer activity. You can download the files for activity 8876 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 following question will guide student exploration in this activity:

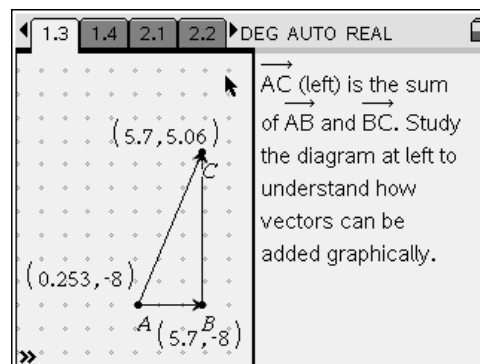
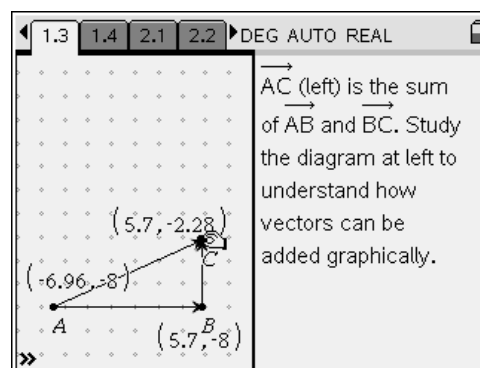
- How can perpendicular vectors be added graphically?

Students will graphically add perpendicular vectors and observe changes in magnitude, angle, x-component, and y-component.

### Exploring the addition of perpendicular vectors

**Step 1:** Students should open the file **PhysBR\_week03\_vectoradd.tns** and read the first two pages. (Students can press  $\text{ctrl} \rightarrow$  and  $\text{ctrl} \leftarrow$  to move between pages in the .tns file.)

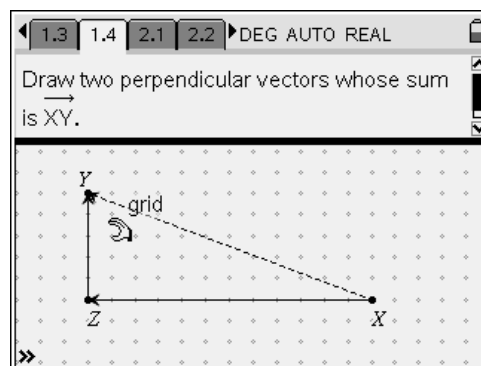
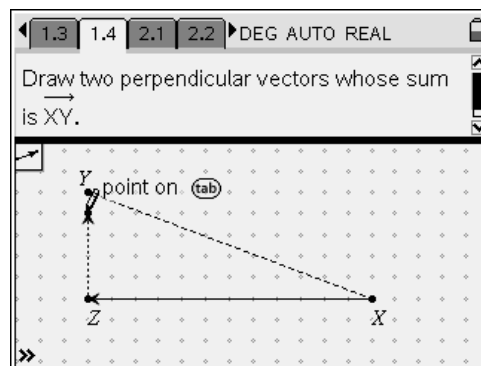
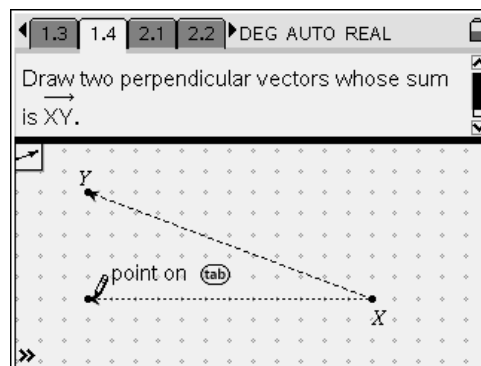
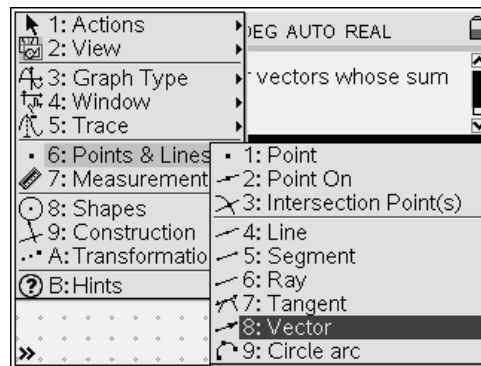
**Step 2:** Students should move to page 1.3 and read the text there. The left side of page 1.3 shows three vectors ( $\overline{AB}$ ,  $\overline{BC}$ , and  $\overline{AC}$ ).  $\overline{AC}$  is the sum of  $\overline{AB}$  and  $\overline{BC}$ . Students should study the diagram to understand how  $\overline{AB}$  and  $\overline{BC}$  were added together. They should particularly focus on how the lengths of  $\overline{AB}$  and  $\overline{BC}$  and the coordinates of points  $A$  and  $B$  are related to the coordinates of point  $C$ , and on how  $\overline{AB}$  and  $\overline{BC}$  are combined (i.e., head-to-tail). They can manipulate points  $A$  and  $C$  to observe how the vectors change. (Students can press  $\text{ctrl} \rightarrow \text{tab}$  to move from the *Notes* application on the right side of the screen to the *Graphs & Geometry* application on the left side of the screen. To move a point, students should use the NavPad to move the cursor until the desired point is highlighted; the cursor will change to an open hand. They should press and hold  $\text{ctrl} \rightarrow$  until the hand closes. They can then use the NavPad to drag the point anywhere on the screen. They should press  $\text{ctrl} \rightarrow$  once more to release the point.)



**Step 3:** Next, students should move to page 1.4. The bottom of page 1.4 contains a *Graphs & Geometry* application with a single vector,  $\overrightarrow{XY}$ , drawn in. Students should draw a set of perpendicular vectors that add to produce  $\overrightarrow{XY}$ . To draw the vectors, students should first select the **Vector** tool from the menu (**Menu > Points & Lines > Vector**). (They should press  $\text{\textcircled{menu}}$  to access the menu.) They should then click once (press  $\text{\textcircled{point}}$ ) on point X. This will insert a single point, which will be the beginning of the vector. Students can press a letter key to label the point. (They can press  $\text{\textcircled{caps}}$  before pressing the letter key to produce a capital letter.) Then, they should use the NavPad to extend the vector across the screen until it is directly below point Y. When the vector is the desired length and direction, students should click once more to end the vector. Students can press a letter key to label the point. (They can press  $\text{\textcircled{caps}}$  before pressing the letter key to produce a capital letter.)

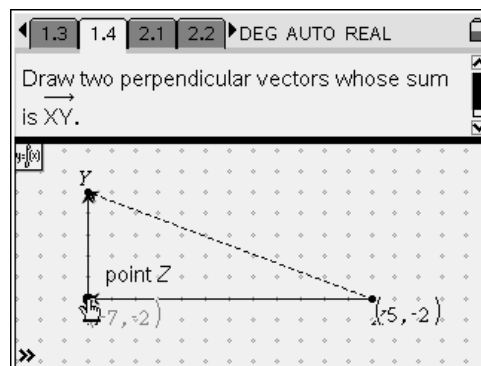
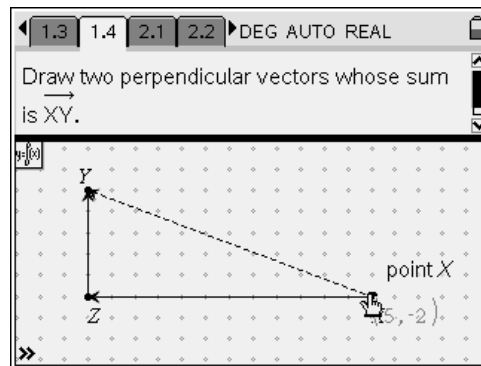
**Step 4:** Students should draw a second vector on page 1.4. It should be perpendicular to the first vector they drew and should end at point Y.

**Step 5:** Encourage students to predict how the lengths of the component vectors and the coordinates of their endpoints are related to the coordinates of  $\overrightarrow{XY}$ . For example, for the vectors shown to the right, students should be able to guess that the x-coordinate of point Y is equal to the x-coordinate of point X plus the length of  $\overrightarrow{XZ}$ .



**Step 6:** Once students have made their predictions, they should use the **Coordinates and Equations** (**Menu > Actions > Coordinates and Equations**) tool to test their predictions. To use the **Coordinates and Equations** tool, students should first select the tool from the menu. Then, they should use the NavPad to move the cursor until the relevant point is highlighted. (The coordinates of the point should be displayed on-screen.) They should click once to label the point with its coordinates. They can then use the NavPad to move the cursor to another point to label its coordinates. When they have labeled the coordinates of all three points, they can press (esc) to exit the tool. They can then calculate the lengths of the component vectors from the coordinates of their endpoints. (Alternatively, students can use the **Length** tool (**Menu > Measurement > Length**) to find the lengths of the component vectors. To use the **Length** tool, students should first select it from the menu and then drag the cursor to the vector they wish to measure. The length of the vector will be displayed. Students can click once to label the vector with its length. They can press (esc) to exit the tool.)

**Extension Questions:** Problem 2 in the student .tns file contains three extension questions. In question 1, students determine the net displacement vector for a taxicab. In question 2, students determine the net force vector on a box. In question 3, students determine the net velocity vector of a boat moving across a river. Students can use the **Length** tool to measure the lengths of the net vectors. They can use the **Text** tool (**Menu > Actions > Text**) to label the vectors. If you wish, you may have students write equations relating the lengths of the three vectors in each situation (i.e., the Pythagorean theorem).



# Bell Ringer: Graphical Vector Addition – ID: 13328

(Student)TI-Nspire File: *PhysBR\_week03\_vectoradd.tns*

|                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1.1 1.2 1.3 1.4 ▸ DEG AUTO REAL</p> <hr/> <p style="text-align: center;"><b>GRAPHICAL VECTOR ADDITION</b></p> <hr/> <p style="text-align: center;"><b>Physics</b></p> <p style="text-align: center;">Vectors</p> | <p>1.1 1.2 1.3 1.4 ▸ DEG AUTO REAL</p> <p>Standard scalar addition (for example, <math>2 + 2</math>) is easy. Adding vectors is more complicated, because vectors have both magnitude and direction. Vectors can be added both graphically and mathematically. In this activity, you will learn how to add vectors graphically.</p> | <p>1.1 1.2 1.3 1.4 ▸ DEG AUTO REAL <span style="float: right;">ctrl</span></p> <p>AC (left) is the sum of AB and BC. Study the diagram at left to understand how vectors can be added graphically.</p> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                                                               |                                                                                                                                                                                                                                              |                                                                                |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| <p>1.1 1.2 1.3 1.4 ▸ DEG AUTO REAL</p> <p>Draw two perpendicular vectors whose sum is XY.</p> | <p>1.2 1.3 1.4 2.1 ▸ DEG AUTO REAL</p> <p>1. A cab driver drives four blocks north and six blocks east. Use the <i>Graphs &amp; Geometry</i> application on the next page to draw the cab driver's path and her net displacement vector.</p> | <p>1.3 1.4 2.1 2.2 ▸ DEG AUTO REAL</p> <p style="text-align: center;">grid</p> |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|

|                                                                                                                                                                                                                                                                                                    |                                                                                |                                                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1.4 2.1 2.2 2.3 ▸ DEG AUTO REAL</p> <p>2. Two students apply forces to a heavy box. Student A applies a force of 5 N eastward. Student B applies a force of 10 N southward. Use the <i>Graphs &amp; Geometry</i> application on the next page to determine the net force vector on the box.</p> | <p>2.1 2.2 2.3 2.4 ▸ DEG AUTO REAL</p> <p style="text-align: center;">grid</p> | <p>2.2 2.3 2.4 2.5 ▸ DEG AUTO REAL</p> <p>3. A fisherman rows a boat across a river. The fisherman rows the boat at an average velocity of 1 m/s north. The river flows at an average velocity of 4 m/s west. Use the <i>Graphs &amp; Geometry</i> application on the next page to determine the boat's net velocity vector.</p> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

2.3 2.4 2.5 2.6 ▸ DEG AUTO REAL ctrl