

### About the Lesson

In this activity students visualize and explore the angles that are formed when two lines intersect. By measuring the angles, students gain a better understanding of *vertical angles*, *supplementary angles*, and adjacent angles. As a result, students will:

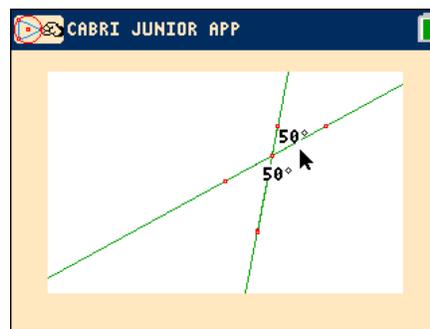
- Construct and measure the angles formed by two intersecting lines using geometric technology tools.
- Analyze angles in a geometric figure to determine the relationships between vertical, supplementary, and adjacent angles.

### Vocabulary

- vertical angles
- supplementary angles
- adjacent angles

### Teacher Preparation and Notes

- This activity uses the Cabri Jr. APP
- A completed Cabri Jr. file is included with the materials.
- The next page of the Teacher Notes gives an introduction explaining that teachers can send the ILAVA Cabri Jr. file or have the students create the dynamic geometry figure themselves. Instructions for the creation are on the next pages and can be printed for the students to have as a guide and reference. The solutions to the questions are on the last pages.



### Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus C Silver Edition. It is also appropriate for use with the TI-84 Plus family with the latest TI-84 Plus operating system (2.55MP) featuring MathPrint™ functionality. Slight variations to these directions given within may be required if using other calculator models.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

### Compatible Devices:

- TI-84 Plus Family
- TI-84 Plus C Silver Edition

### Associated Materials:

- Vertical\_Angles\_Student.pdf
- Vertical\_Angles\_Student.doc
- ILAVA.8xv

**Introduction**

Intersecting lines are one of the most common figures in geometry. In this exploration, students will investigate the properties of angles formed by intersecting lines. The outcome of the activity will produce two important geometric theorems dealing with vertical and supplementary angles.

This activity makes use of the following definitions:

**adjacent angles:** two angles with a common vertex and a common side but no common interior points.

**supplementary angles:** two angles whose sum is  $180^\circ$ .

**vertical angles:** two non-adjacent angles formed by two intersecting lines.

This activity can proceed in one of two ways. You can have the students create the ILAVA.8xv file using Cabri Jr., or you can download the file and send it to their calculators. The .8xv extension is the extension for a TI-84 application variable. The directions for creating the file are given on the following pages and can be passed out to the students or done as a teacher-directed activity with the students following along.

**Part 1 – Creating the Cabri Jr. File**

If you want the students to create their own files, copy the directions on the next two pages and pass them out to the class. If students are new to Cabri Jr., make sure that they pay careful attention to the blinking points and lines as they proceed. Angle measures will be off if they measure to the line instead of the point. If students are creating their own files, their angle measures will be different from those shown. When you save the file and name it, the calculator will already be in alpha mode, so you can access the letters in the upper right of the keys by just pressing the key. The F1 – F5 keys are the grey keys just below the screen.

**Part 2 – Exploration**

Students should open the **ILAVA** file. Help them, if necessary, with opening the file. If you sent them the downloaded file they will need to measure three of the remaining angles. If they created their own file they will need to measure any missing angles. Measuring an angle is much like naming an angle. Start with a point on a side, then the vertex, and then a point on the other side. Directions are shown on the student sheet. Emphasize to students that the point should be blinking before they select **[ENTER]**.

Similarly, when students move the arrow over to point B or point C, it should be blinking so that they can grab it by pressing **[ALPHA]**. The **[CLEAR]** key can be used to exit a tool.

**Part 3 – Questions and Conjectures**

In this section students should be able to describe the relationships between the angles formed by two intersecting line and apply these relationships to solve a simple problem.

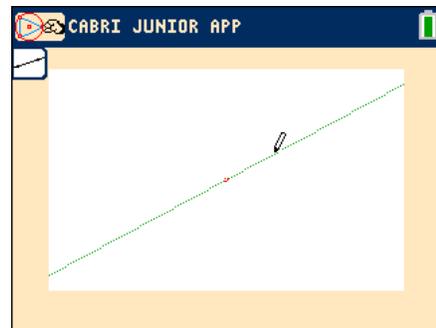
### Part 1 – Directions for Creating Intersecting Lines and Vertical Angles Using Cabri Jr.

In this activity students will be creating a dynamic file to investigate the angle relationships formed by two intersecting lines.

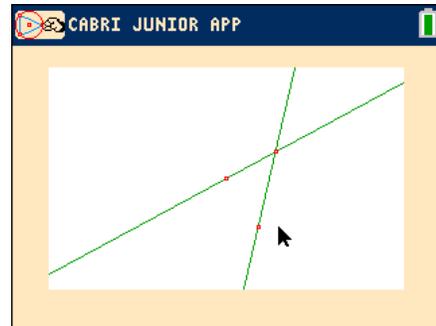
Have students press [APPS]. Then, they should move down to the Cabri Jr. APP and press [ENTER]. Have students press [Y=] for the F1 menu and select **New**. (If asked to **Save changes?** press [◀] [ENTER] to choose “No.”)



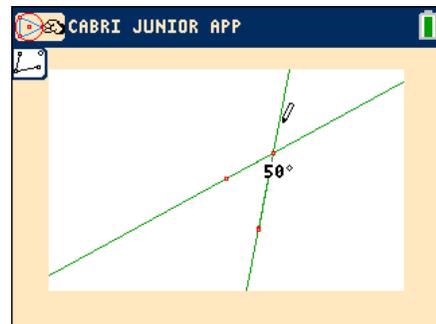
Students should press [WINDOW] for the F2 menu and press [▼] [ENTER] to select **Line**. Then, have students press [ENTER] to mark one point on the line. Students should move the pointer [▲] and [▶] several times and press [ENTER] to mark the other point defining the line.



The **Line** tool is still active (notice the icon in the upper left of the screen), so students should press [ENTER] again to mark this point as one of the points that will determine another line. Have students press [▼] to move away from that point and press [ENTER] to mark the other point on the new line. Then, have students press [CLEAR] to disable the **Line** tool. (Notice the icon to the upper left is gone.)



Have students use F5 to measure the angle formed by the 3 marked points. They should press [GRAPH] for the F5 menu, move to Measure, then move to Angle and press [ENTER]. Have students move the pencil to the first marked point on a side. The point should blink and students should press [ENTER]. Then, have students move to the vertex, and when the point is blinking they should press [ENTER]. Finally, have students move to the third point, and when it is blinking they should press [ENTER]. The angle measure will appear. Students should move the angle measure to a convenient location and press [CLEAR] to deactivate the *hand*.

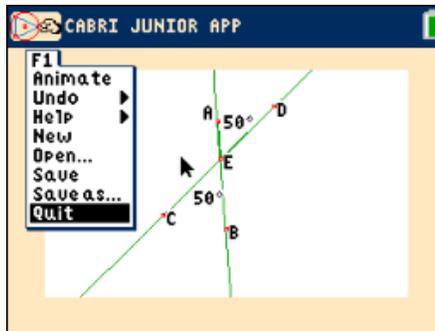
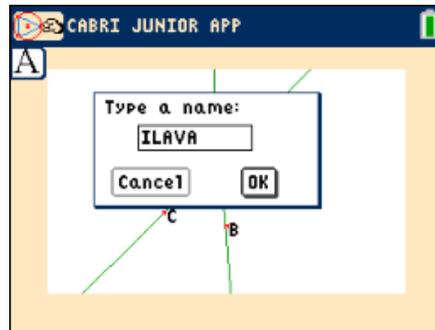
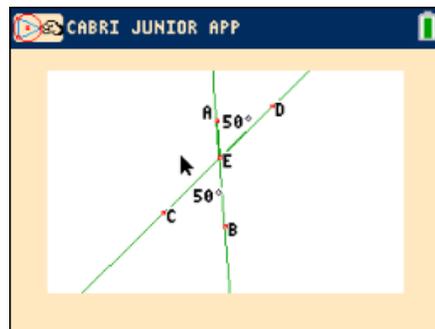
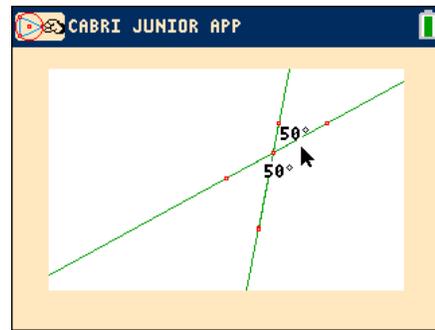


The **Angle Measure** tool is still active, so now have students use it to mark points forming the other vertical angle. Students will first mark a point on one line, move to the intersection point, and then mark a point on the second line. When marking a point on a line, students should make sure the line is blinking. When the angle measure is displayed it can be moved to a convenient location. Have students press **CLEAR** to deactivate the *hand*. Students can press **CLEAR** to deactivate the Angle Measure tool.

Next, have students label the points use F5. To do this, they should press **GRAPH** for the F5 menu, scroll down to **Alph-Num** and press **ENTER**. A cursor will appear. Have students move to one of the points they want to label and when the point is blinking, they should press **ENTER**. This will open a text box. Have students type in the letter and press **ENTER** to close the text box. They should repeat these steps to label all five points as shown.

To save the file have students press **Y=** for the F1 menu, scroll down to **Save as** and press **ENTER**. Have students type in the name **ILAVA** as shown and press **ENTER** to select **OK**.

To exit the APP, have students press **Y=** for the F1 menu. Students should move to **Quit**, then press **ENTER**. (Or, they can press **2nd** **MODE** for **QUIT**.)



**Part 1 – Creating or Sending the ILAVA file**

Provide students with directions to create the Cabri Jr file ILAVA.8xv (as discussed above), or send the file directly to student calculators. Once students have the file ILAVA, they should proceed to Part 2.

**Teacher Tip:** Check the students' files to make sure the construction is correct. The easiest way to check is to grab point B or C and see if the vertical angles change. Look at the downloaded file to see how the correctly constructed lines operate.

**Part 2 – Exploration**

Make sure that all angle measures are included in the student diagrams. If they are not, have students measure the remaining angles using **F5 > Measure > Angle**.

**Teacher Tip:** Check the students' calculators to make sure all four angles are measured.

Have students use the arrow keys to move the cursor so that either point C or Point B is blinking. They should grab the point by pressing **[ALPHA]**.

Have students use the arrow keys to change the size of the angles by dragging the point.

Students should observe the changes in the measures of the angles and note how they are related.

**Teacher Tip:** Check the students' calculators to make sure they are dragging points B or C to get different angle measurements.

**Part 3 – Questions and Conjectures**

1. Identify all pairs of vertical angles and make conjectures about their measurements.

**Answer:**  $\angle DEB$  and  $\angle CEA$  are vertical angles.  $\angle AED$  and  $\angle BEC$  are vertical angles. The measures of the vertical angles are equal.

2. Identify all pairs of adjacent angles and make conjectures about their measurements.

**Answer:**  $\angle AEC$  and  $\angle CEB$ ,  $\angle CEB$  and  $\angle BED$ ,  $\angle BED$  and  $\angle DEA$ ,  $\angle DEA$  and  $\angle AEC$  are all pairs of adjacent angles. Adjacent angles formed by intersecting lines are supplementary. The sum of their angle measures equals  $180^\circ$ .

**Teacher Tip:** Have students critique each other's conjectures. Or present a hypothetical conjecture for them to discuss and critique. For example, "Students, what would you say if George conjectures that adjacent angles formed by intersecting lines are complimentary?"

3. If  $m\angle DEB$  is  $90^\circ$ , what would be the measure of the remaining angles? Verify your answer using the construction. Write a conjecture about two lines that intersect at a  $90^\circ$  angle.

**Answer:** Students should conclude that perpendicular lines form right angles, and all right angles are congruent. If one angle measures  $90^\circ$ , its vertical angle is congruent and the measure of the adjacent angle is  $180^\circ - 90^\circ = 90^\circ$ .

4. Find the measures of the remaining angles in the diagram at the right.

**Answer:**  $m\angle DEB = 80^\circ$  and  $m\angle CEA = 80^\circ$  and  $m\angle AED = 100^\circ$

