



### Math Objectives

- Students will use the definitions of supplementary, complementary, vertical, and adjacent angles to determine missing measures of angles ( $m\angle$ ) in a sketch.
- Students will describe their methodology as they use multi-step analyses of a sketch to determine missing angle measures.
- Students will use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure (CCSS Mathematical Standard).
- Students will reason abstractly and quantitatively (CCSS Mathematical Practice).

### Vocabulary

- supplementary angles
- complementary angles
- vertical angles
- adjacent angles

### About the Lesson

- This lesson involves looking at several sketches of intersecting lines and determining the measures of the missing angles using the facts about supplementary, complementary, vertical, and adjacent angles.
- As a result, students will:
  - Use several facts in tandem to get their solutions.
  - Show their work as they move through the steps to obtain all of the angle measures.



### TI-Nspire™ Navigator™

- Transfer a document.
- Use Class Capture to examine student work and progress.
- Use Live Presenter to let students show their methodology and to verify measures.
- Use Quick Poll for Formative and Summative Assessment.

### Activity Materials

Compatible TI Technologies:  TI-Nspire™ CX Handhelds,



TI-Nspire™ Apps for iPad®,  TI-Nspire™ Software



### Tech Tips:

- This activity includes screen captures from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>

### Lesson Files:

*Student Activity*  
 Angles\_for\_a\_Solution\_Student.pdf  
 Angles\_for\_a\_Solution\_Student.doc  
*TI-Nspire document*  
 Angles\_for\_a\_Solution.tns

Visit [www.mathnspired.com](http://www.mathnspired.com) for lesson updates and tech tips.



### Discussion Points and Possible Answers

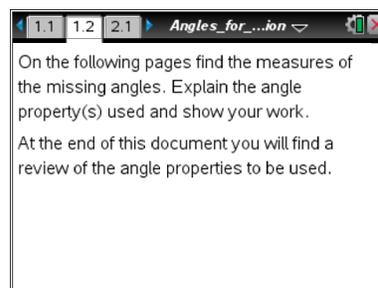
**Teacher Tip:** Students will be inclined to measure the missing angles. This will be fine as a verification of their work. Be aware that they might get a rounding error and that by adjusting the Attributes of the measures to a “0” level of Custom Precision, all should be fine.

The power of knowing the rules and definitions of mathematics is, in part, to reduce one’s workload. For example, in a figure with several angles, you need not measure all of the angles to “know” the system. If you collect a few strategic measures, you can apply facts about supplementary, complementary, vertical, and adjacent angles to determine the remaining measures in the system.

**Teacher Tip:** If students need a review of supplementary, complementary, vertical, and adjacent angles, refer them to Problem 7 in the TI-Nspire document.

#### Move to page 1.2.

On the following pages, find the measures of the missing angles. Be sure to explain your rationale for determining the missing angles using the fact(s) for these angles. Also, show the mathematical steps used to determine the angle measures.



Place your work on a new page on your handheld (press **ctrl** **I**) or on paper as you feel appropriate.



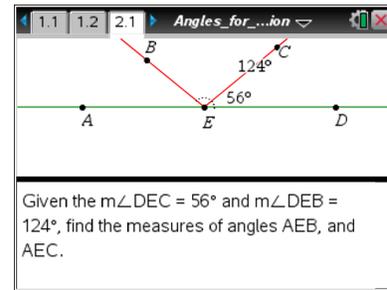
**Tech Tip:** To add a new Calculator page, press **+** and select Calculator.

**Tech Tip:** If students create their own sketches and if they use the Graph page, looking at the angles in a Square window will help with the visualization of the relationships between angles. Remember the sketches are not to scale!



Move to page 2.1.

- Given the measures of angles  $m\angle DEC = 56^\circ$  and  $m\angle DEB = 124^\circ$ , find the  $m\angle AEB$  and  $m\angle AEC$ .



**Sample Answers:** Since angle DEB measures 124 degrees and angle DEA is composed of the two supplementary angles DEB and AEB, we have:

$$180 = 124 + \text{AEB}$$

$$\text{AEB} = 180 - 124$$

$$\text{AEB} = 56$$

So the measure of angle AEB is 56 degrees.

In a similar way, with angle DEC measuring 56 degrees and the fact that angles DEC and AEC are supplementary, we have

$$180 = \text{AEC} + 56$$

$$\text{AEC} = 180 - 56$$

$$\text{AEC} = 124$$

So the measure of angle AEC is 124 degrees.

**Teacher Tip:** Students can produce their solution in the TI-Nspire document using a Calculator and/or Notes page. Watch that they combine words and equations or expressions with an emphasis on the facts about the four angle types. You might need to walk the class through the solution for at least one angle on this first sketch.

The student answers can be verified in several ways. Using the TI-Nspire Navigator to collect answers for particular angles might work as well as asking which angle fact precipitated the measure. A Quick Poll or Class Capture might work well but should be used after the students create the solutions for all drawings.



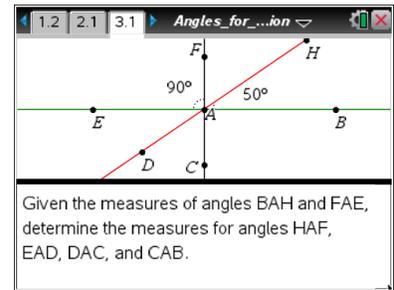
**TI-Nspire Navigator Opportunity: *Class Capture and Live Presenter***

**See Note 1 at the end of this lesson.**



Move to page 3.1.

- Given the measures of angles BAH and FAE, determine the  $m\angle HAF$ ,  $m\angle EAD$ ,  $m\angle DAC$ , and  $m\angle CAB$ .



**Sample Answers:** Angle HAF is complementary with angle BAH so,

$$90 = \text{HAF} + 50$$

$$\text{HAF} = 90 - 50$$

$$\text{HAF} = 40$$

The measure of angle HAF is 40 degrees.

Angle EAD forms a vertical angle with angle BAH which measures 50 degrees, so angle EAD measures 50 degrees.

Angle DAC is complementary with angle EAD since the measure of angle FAE is 90 degrees.

Therefore,

$$90 = \text{DAC} + 50$$

$$\text{DAC} = 90 - 50$$

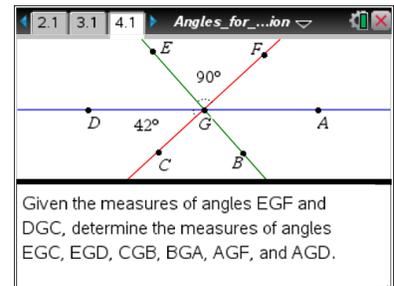
$$\text{DAC} = 40$$

So angle DAC measures 40 degrees.

Angle CAB and angle FAE form vertical angles so the measure of angle CAB is 90 degrees.

Move to page 4.1.

- Given the measures of angles EGF and DGC, determine the  $m\angle EGC$ ,  $m\angle EGD$ ,  $m\angle CGB$ ,  $m\angle BGA$ ,  $m\angle AGF$ , and  $m\angle AGD$ .



Move to pages 4.2 through 4.9.

- On each page, type your measures in the space below each question.

**Sample Answers:** The first two angles are given, so Angle EGF measures 90 degrees and Angle DGC measures 42 degrees. Since angles EGF and EGC are supplementary, we have

$$\text{EGF} + \text{EGC} = 180$$

$$90 + \text{EGC} = 180$$

$$\text{EGC} = 90$$

So angle EGC measures 90 degrees.



Angles EGD and DGC are complementary since

$$EGD + DGC = EGC$$

so we have

$$EGD + DGC = 90$$

$$EGD + 42 = 90$$

$$EGD = 90 - 42$$

$$EGD = 48$$

So angle EGD measures 48 degrees.

Since angles CGB and EGF are vertical angles, we have the measure of angle CGB is 90 degrees.

Angles BGA and EGD are also vertical angles, so we have the measure of angle BGA is 48 degrees.

And again, since angles AGF and DGC are vertical angles, they both have a measure of 42 degrees.

Angles AGF and FGE are adjacent angles and form the angle AGE. The measure of angle AGE is the sum of the measures of angles AGF and FGE, angle AGE measures  $90 + 42 = 132$  degrees. Angles AGE and EGD are adjacent and form angle AGD, the measure of which is the sum of the measures of angles AGE and EGD. This gives  $132 + 48 = 180$ , so the measure of angle AGD is 180 degrees.

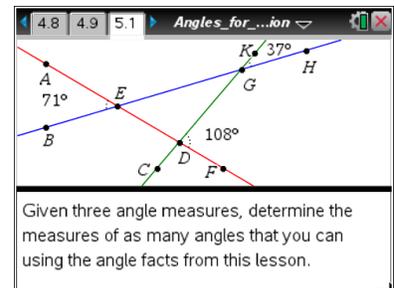


**TI-Nspire Navigator Opportunity: *Class Capture and Quick Poll***

**See Note 2 at the end of this lesson.**

**Move to page 5.1.**

- Given three angle measures, determine the measures of the remaining angles. Don't forget to explain which fact(s) allowed you to determine each measure.



**Sample Answers:** Angle AEG is supplementary with angle AEB so,

$$AEG + AEB = 180$$

$$AEG + 71 = 180$$

$$AEG = 180 - 71$$

$$AEG = 109$$

The measure of angle AEG is 109 degrees.

Angle BED and AEG are vertical angles so their measures are the same. The measure of angle BED is 109 degrees.



Angle CDE and GDF are vertical angles so their measures are the same. The measure of angle CDE is 108 degrees.

Angle CDF is supplementary with angle FDG so,

$$CDF + FDG = 180$$

$$CDF + 108 = 180$$

$$CDF = 180 - 108$$

$$CDF = 72$$

The measure of angle CDF is 72 degrees.

Angle GDE and CDF are vertical angles so their measures are the same. The measure of angle GDE is 72 degrees.

Angle DEG and BEA are vertical angles so their measures are the same. The measure of angle DEG is 71 degrees.

Angle EGK is supplementary with angle KGH so,

$$EGK + KGH = 180$$

$$EGK + 37 = 180$$

$$EGK = 180 - 37$$

$$EGK = 143$$

The measure of angle EGK is 143 degrees.

Angle DGH is supplementary with angle KGH so,

$$DGH + KGH = 180$$

$$DGH + 37 = 180$$

$$DGH = 180 - 37$$

$$DGH = 143$$

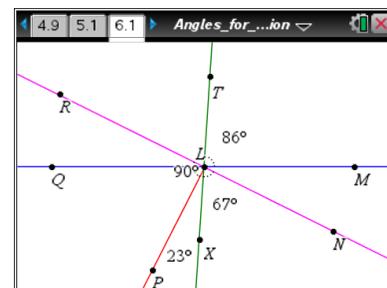
The measure of angle DGH is 143 degrees.

**Teacher Tip:** Watch for alternative angle names (e.g., AEG – GEA; AEH – HEA) and for angle measures determined by facts not included in this lesson (e.g., The sum of the angles in a triangle is 180 degrees.).

**Teacher Tip:** Use page 6.1 for assessment or additional practice.

### Page 6.1. (Optional)

- Wait for teacher instruction if this page is assigned.





**Teacher Tip:** The measure of angle RLP is 90 degrees.



**Tech Tip:** If students start a new TI-Nspire document and use the Measurement tool, they will need to make sure the measurements are in degrees rather than radians. This change can be made by clicking the icon at the top right of the screen (to the left of the X) or from the Home screen under Settings.



**Tech Tip:** To change the angle settings in a new document from radians to degrees, press , select Radian, and press Done.

## Wrap Up

Upon completion of the lesson, the teacher should ensure that students are able to understand:

- The facts about supplementary, complementary, vertical, and adjacent angles.
- How to use those facts in mathematical expressions or equations to determine unknown values for angles shown in a sketch.



## TI-Nspire Navigator

### Note 1

#### Question 1, Class Capture and Live Presenter

Use Class Capture to determine that all students are on the first sketch. Make a student the Live Presenter and have the student show the solution.

### Note 2

#### Question 4, Class Capture and Quick Poll

Use Class Capture or Quick Poll to collect answers for particular angles. In addition, use this technique to determine which angle fact precipitated the measure.