



### About the Lesson

In this activity, students will use a graphing calculator to discover the relationship between the trigonometric functions: sine, cosine, and tangent, and the ratios of the side lengths of a right triangle. As a result, students will:

- Solve any right triangle given an angle and the length of an opposite or adjacent side.
- Use technology to obtain the sine, cosine, or tangent of any angle.

### Vocabulary

- opposite side
- adjacent side
- hypotenuse
- sine ratio
- cosine ratio
- tangent ratio

### Teacher Preparation and Notes

- This activity is designed as an introduction to the world of trigonometry.
- Prior to beginning the activity, students should download the Cabri Jr file, *TRIG*, to their graphing calculators. If students are not experienced with using Cabri Jr, extra time should be allotted for the activity.
- This activity is intended to be teacher-led. You may use the following pages to present the material to the class and encourage discussion. Students will follow along with their handhelds in addition to recording their answers on the accompanying student worksheet.


### Activity Materials

- Compatible TI Technologies:

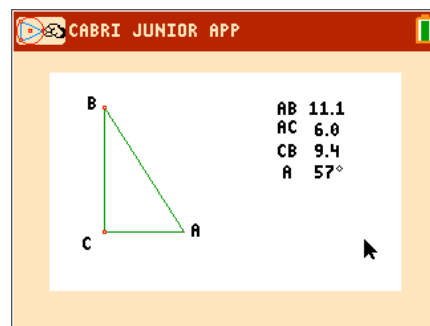
TI-84 Plus\*

TI-84 Plus Silver Edition\*

 TI-84 Plus C Silver Edition

 TI-84 Plus CE

\* with the latest operating system (2.55MP) featuring MathPrint™ functionality.



### Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus CE. It is also appropriate for use with the rest of the TI-84 Plus family. Slight variations to these directions may be required if using other calculator models.
- 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>
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

### Lesson Files:

- Trig\_Ratios\_Student.pdf
- Trig\_Ratios\_Student.doc
- TRIG.8xv



**Tech Tip:** Before beginning the activity, the file TRIG.8xv needs to be transferred to the students' calculators via handheld-to-handheld transfer or transferred from the computer to the calculator via TI-Connect™ CE Software.

### Problem 1 – Investigation

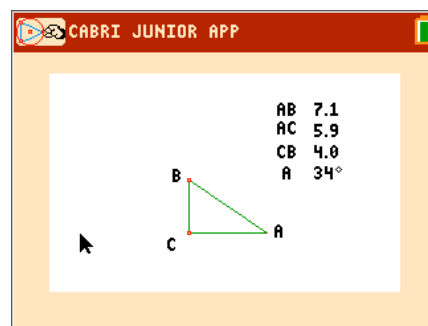
Students are to start the **Cabri Jr.** app and open the file *TRIG*.

Explain to students that in right triangles (triangles with a right angle), there is a relationship between the ratios of the side lengths and the trigonometric functions.

**Teacher Tip:** You may manipulate the side lengths of the triangle as well as the measure of angle **A** to any measurements you want. The examples below illustrate three such configurations.

To resize the triangle, place the cursor over either point **A** or **B**.

Press **[alpha]** to grab the point and use the arrow keys to move it to any desired location.



Record the ratios and trigonometric values to two decimal places.

1.  $\frac{CB}{AC} = \frac{4.0}{5.9} \approx 0.68$ ;  $\frac{AC}{AB} = \frac{5.9}{7.1} \approx 0.83$ ;  $\frac{CB}{AB} = \frac{4.0}{7.1} \approx 0.56$

**Sample Answers:**

$$\frac{CB}{AC} = \frac{4.0}{5.9} \approx 0.68; \frac{AC}{AB} = \frac{5.9}{7.1} \approx 0.83; \frac{CB}{AB} = \frac{4.0}{7.1} \approx 0.56$$

2.  $\sin A = 0.56$ ;  $\cos A = 0.83$ ;  $\tan A = 0.68$

**Sample Answers:**

$$\sin A = 0.56; \cos A = 0.83; \tan A = 0.68$$



**Note:** Make sure that students set the calculator's mode to degrees. To do this, press **[mode]** and arrow down to the line with the options **RADIAN** and **DEGREE**. Select **DEGREE** and press **[enter]**.

Repeat this for two more different triangles by moving either point **A** or **B** to a different location. To resize the triangle, place the cursor over either point **A** or **B**. Press **[alpha]** to grab the point and use the arrow keys to move it to any desired location.

### Triangle #2

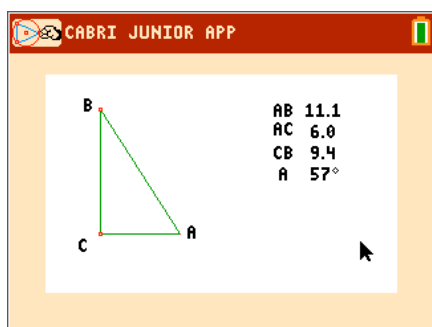
3.  $\frac{CB}{AC} = \frac{\quad}{\quad} \approx \frac{\quad}{\quad}$ ;  $\frac{AC}{AB} = \frac{\quad}{\quad} \approx \frac{\quad}{\quad}$ ;  $\frac{CB}{AB} = \frac{\quad}{\quad} \approx \frac{\quad}{\quad}$

$\sin A = \frac{\quad}{\quad}$ ;  $\cos A = \frac{\quad}{\quad}$ ;  $\tan A = \frac{\quad}{\quad}$

**Sample Answers:**  $\frac{CB}{AC} = \frac{9.5}{6.0} \approx 1.54$ ;

$\frac{AC}{AB} = \frac{6.0}{11.1} \approx 0.54$ ;  $\frac{CB}{AB} = \frac{9.4}{11.1} \approx 0.84$

$\sin A = 0.83$ ;  $\cos A = 0.54$ ;  $\tan A = 1.54$



### Triangle #3

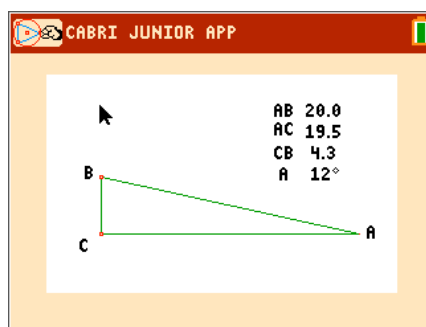
4.  $\frac{CB}{AC} = \frac{\quad}{\quad} \approx \frac{\quad}{\quad}$ ;  $\frac{AC}{AB} = \frac{\quad}{\quad} \approx \frac{\quad}{\quad}$ ;  $\frac{CB}{AB} = \frac{\quad}{\quad} \approx \frac{\quad}{\quad}$

$\sin A = \frac{\quad}{\quad}$ ;  $\cos A = \frac{\quad}{\quad}$ ;  $\tan A = \frac{\quad}{\quad}$

**Sample Answers:**  $\frac{CB}{AC} = \frac{4.3}{20.0} \approx 0.21$ ;

$\frac{AC}{AB} = \frac{19.5}{20.0} \approx 0.98$ ;  $\frac{CB}{AB} = \frac{4.3}{19.5} \approx 0.22$

$\sin A = 0.21$ ;  $\cos A = 0.98$ ;  $\tan A = 0.21$



Discuss with students that due to rounding variances, the trigonometric ratio may differ by  $\pm 0.1$  from the ratio of the two corresponding sides.

Based upon your answers hypothesize which ratio goes with each trigonometric function.

5.  $\sin A = \frac{\quad}{\quad}$ ;  $\cos A = \frac{\quad}{\quad}$ ;  $\tan A = \frac{\quad}{\quad}$

**Answers:**

$\sin A = \frac{BC}{AB}$ ;  $\cos A = \frac{AC}{AB}$ ;  $\tan A = \frac{BC}{AC}$

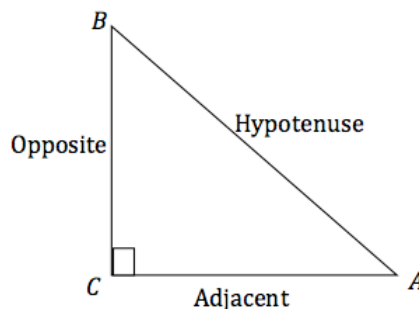


A good acronym to use to help remember these relationships is SOHCAHTOA.

$$\sin A = \frac{\text{Opposite}}{\text{Hypotenuse}}$$

$$\cos A = \frac{\text{Adjacent}}{\text{Hypotenuse}}$$

$$\tan A = \frac{\text{Opposite}}{\text{Adjacent}}$$



### Problem 2 – Trigonometry, What is it good for?

Now students will use trigonometric ratios to find missing side lengths of a triangle. They are given the relationship (sine/cosine/tangent) that they are supposed to use for each of the three problems.

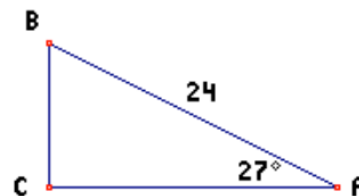
6. a. To find the length of side  $BC$  in the triangle to the right, write the sine relationship.

**Answer:**  $\sin A = \frac{BC}{AB}$

- b. Now solve for  $BC$  and calculate using your calculator.

$$\sin 27 = \frac{BC}{24}$$

**Answer:**  $24(\sin 27) = BC$   
 $24(0.45) = BC$   
 $10.90 = BC$



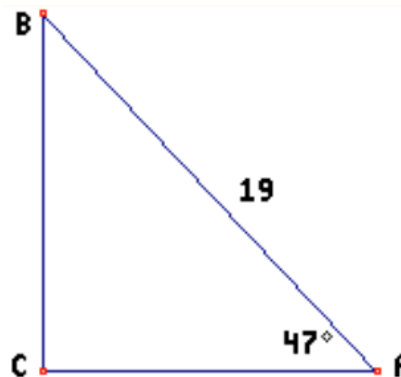
7. a. To find the length of side  $AC$  in the triangle to the right, write the cosine relationship.

**Answer:**  $\cos A = \frac{AC}{AB}$

- b. Now solve for  $AC$  and calculate using your calculator.

$$\cos 47 = \frac{AC}{19}$$

**Answer:**  $19(\cos 47) = AC$   
 $19(0.67) = AC$   
 $12.71 = AC$





8. a. To find the length of side  $AC$  in the triangle to the right, write the tangent relationship.

**Answer:**  $\tan A = \frac{BC}{AC}$

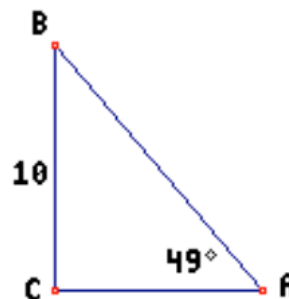
- b. Now solve for  $AC$  and calculate using your calculator.

$$\tan 49 = \frac{10}{AC}$$

**Answer:**  $AC(\tan 49) = 10$

$$AC = \frac{10}{\tan 49}$$

$$AC = \frac{10}{1.15} \approx 8.7$$



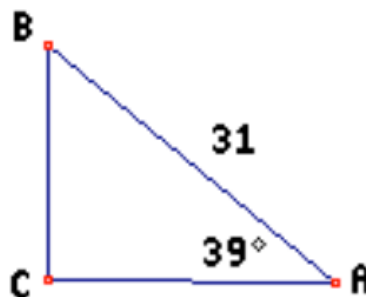
Lastly, students will use what they've learned and apply it. They are given a triangle and are told to find the length of certain side. This time, students will need to decide which trigonometric function to use.

9. Find  $AC$ .



**Answer:**  $AC = 14.62$

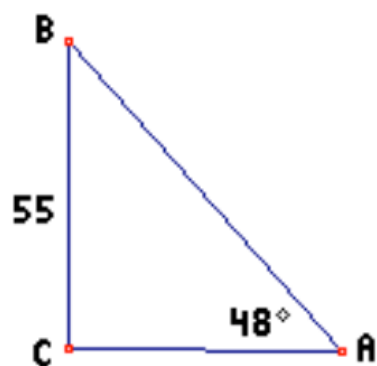
10. Find  $BC$ .



**Answer:**  $BC = 19.51$



11. Find AC.



Answer:  $AC = 49.52$

12. Find AC.



Answer:  $AC = 95.09$