**Unit 4: Investigation 6 (4 Days)**

**Right Triangle Trigonometry**

**Common Core State Standards**

* G-SRT.C.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
* G-SRT.C.7 Explain and use the relationship between the sine and cosine of complementary angles.
* G-SRT.C.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.\*

**Overview**

In this investigation students will begin by discovering the sine, cosine, and tangent ratios. They will learn to use a calculator to apply these ratios to find an unknown side or angle of a right triangle. Students will then sharpen their understanding of these ratios by applying them in real-world problems. Lastly, students will explore relationships between the sine and cosine functions.

**Assessment Activities**

**Evidence of Success: What Will Students Be Able to Do?**

* Solve right triangles with given information.
* Apply trigonometric ratios in problems that are based in real world contexts.
* Solve modeling problems involving trigonometric ratios.
* Write values of the sine and cosine function in terms of their co-function.

**Assessment Strategies: How Will They Show What They Know?**

* **Exit Slip 4.6.1** requires students to identify basic trigonometric ratios.
* **Exit Slip 4.6.2** requires students to solve a real-world problem involving a trigonometric ratio and the Pythagorean Theorem.
* **Journal Entry** requires students to explain in what situations right triangle trigonometry can be used along with an explanation to an absent student of how to solve problems involving them.

**Launch Notes**

There are many real-world applications that involve right triangle trigonometric ratios. You might begin by posing a real-world situation that requires right triangle trigonometry, such as a problem from **Activity 4.7.3**. While at this point students most likely are not able to solve this task, understanding the problem will help them to see the need for right triangle trigonometry.

**Teaching Strategies**

In **Activity 4.6.1** **Ratios in Right Triangles** students will use a dynamic geometry software program to discover the Sine, Cosine, and Tangent ratios. Students will then apply this understanding to problems in which they are asked to find the unknown side of a triangle. **Note:** Students will use a calculator with SIN, COS, and TAN functions in this activity and in subsequent ones. Make sure students’ calculators are in degree (not radian) mode.

Following this activity you may assign **Exit Slip 4.6.1.**

In **Activity 4.6.2** **Inverse Trigonometric Functions** students will learn the inverse trigonometric functions on the calculator to solve for acute angle measures in right triangles. They will apply this knowledge to problems based in real world contexts.

Be sure to emphasize the caution on page 1 of **Activity 4.6.2:**

**Caution: *tan*–1 does not mean** $\frac{1}{tan}$

This is a frequent source of misunderstanding. Encourage students to read “tan–1” as “inverse tan,” not “tan to the –1.”

Before introducing **Activity 4.6.3 Applications of Right Triangle Trigonometry**, introduce students to the definitions of **angle of elevation** and **angle of depression.**

**Differentiated Instruction (For Learners Needing More Help)**

Many students readily understand angle of elevation but get confused which angle is the angle of depression. Emphasis that both angles are measured from horizontal lines.



In the diagram $∠CAB$ is an angle of elevation and $∠DCA$ is an angle of depression. Because $\overbar{DC }∥ \overbar{AB}$, these two angles are congruent by the Alternate Interior Angles Theorem. $∠ACB$ is not an angle of depression.

The angle of depression is sometimes called an **angle of descent** as when an airplane descents from *C* to land on the ground at *A*.

In **Activity 4.6.3**, students solve real world problems that involve the Pythagorean theorem, solving for angle measures, and measures of sides in right triangles. Many of the problems require students to draw an appropriate diagram based on information that is given in verbally.

**Differentiated Instruction (For Learners Needing More Help)**

English Language Learners may have difficulty understanding some of these problems. You may provide these students with a diagram so they can engage immediately with the mathematics. You may also give them Exit Slip 4.6.2b, which does not require them to draw the diagram.

Following this activity you may assign **Exit Slip 4.6.2.** There are two versions, *a* and *b*, with the latter designed for English Language Learners as described above.

In **Activity 4.6.4**, through the use of graphs and tables, students will discover relationships between trigonometric co-functions.

**Differentiated Instruction (Enrichment)**

In this course we introduce students to only three trigonometric functions—sine, cosine, and tangent. Some students may want to learn about the other three functions—cotangent, secant, and cosecant—and explore the co-function relationships between tangent and cotangent and between secant and cosecant.

**Closure Notes**

Ask students to answer the following questions in regard to each topic.

Pythagorean Theorem

 For what is it used?

 When can I use it?

 What do I need to be careful about when using it?

Trigonometric Ratios

 For what is it used?

 When can I use it?

 What do I need to be careful about when using it?

Inverse trigonometric functions

 For what is it used?

When can I use it?

What do I need to be careful about when using it?

**Group Activity**

Have students brainstorm answers to the above questions and share their conclusions with the whole class as part of the closure.

**Journal Entry**

Explain to a student who has been absent how the Pythagorean Theorem and trigonometric ratios are used to solve real world problems. Look for students to emphasize that these tools are used to solve right triangles and to use appropriate vocabulary: hypotenuse, leg, adjacent, opposite.

**Vocabulary**

Adjacent (leg)

Opposite (leg)

Sine of Theta (sin$ θ)$

Cosine of Theta (cos$ θ)$

Tangent of Theta (tan$ θ)$

Inverse Sine (sin–1 $θ)$

Inverse Cosine (cos–1 $θ)$

Inverse Tangent (tan–1 $θ)$

Angle of elevation

Angle of depression

Angle of descent

**Resources and Materials**

Activities:

 Activity 4.6.1 Ratios in Right Triangles

 Activity 4.6.2 Inverse Trigonometric Functions

 Activity 4.6.3 Applications of Right Triangle Trigonometry

 Activity 4.6.4 Complementary Angles and Cofunctions

Geogebra file for Activity 4.6.1: ctcoregeomACT461.ggb

Students should have calculators with trigonometric functions (e.g TI-84)