Right Triangle Relationships and Trigonometry Unit Guide

Geometry

Big Idea (Clusters):
Prove theorems involving similarity.
Define trigonometric ratios and solve problems involving right triangles.
Apply geometric concepts in modeling situations.

(Two week unit, approximately)
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**Clusters:**
- Prove theorems involving similarity.
- Define trigonometric ratios and solve problems involving right triangles.
- Apply geometric concepts in modeling situations.

G.SRT standards are considered “major content” and may potentially be assessed across multiple claims on the Smarter Balanced summative assessment.

**G.SRT.6 – 8 will be assessed through Claims 1 and 2 assessment items.** Claim 1, Concepts and Procedures, asks students to explain and apply mathematical concepts and carry out mathematical procedures with precision and fluency. Claim 2, Problem Solving, asks students to solve a range of complex well-posed problems in pure and applied mathematics, making productive use of knowledge and problem solving strategies.

**Standard G.SRT.5** Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

**Standard G.SRT.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.

**Standard G.SRT.7** Explain and use the relationship between the sine and cosine of complementary angles.

**Standard G.SRT.8** Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. ★

**Standard G.MG.1** Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*

**Standard G.MG.3** Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*
### Relevant Math Practices and Student Actions

#### MP 1 Make sense of problems and persevere in solving them.
- Perseveres when solving problems.
- Understands what the problem asks and the relationship among the problem’s parts.
- Looks for an entry point into solving the problem.
- Makes a plan for solving a problem.
- Uses multiple strategies and representations.
- Explains why a solution is reasonable.

#### MP 2 Reason abstractly and quantitatively.
- Interprets problems in context.
- Uses representations to make meaning of problems.
- Translates a problem from situation to equation.
- Creates a situation for a given equation.
- Explains connections between equation and situation.

#### MP 3 Construct viable arguments and critique the reasoning of others.
- Uses definitions and draws on prior mathematical knowledge when constructing arguments.
- Makes conjectures and evaluates their accuracy.
- Justifies conclusions with mathematical evidence and responds to arguments of others.
- Communicates and defends mathematical reasoning using objects, drawings, diagrams, actions, examples and counterexamples.
- Asks clarifying and probing questions to improve argument.

#### MP 4 Model with mathematics.
- Applies prior mathematical knowledge to describe, analyze, and solve problems arising in everyday life, society and workplace.
- Identifies quantities necessary to solve a problem and uses representations to map their relationships.

#### MP 5 Use appropriate tools strategically.
- Selects tools strategically for visualizing, exploring, comparing, predicting, and solving problems.
- Uses technological tools and resources to pose problems, solve problems and deepen understanding.

#### MP 6 Attend to precision.
- Communicates mathematical thinking accurately both orally and in writing.
- Understands the meaning of mathematical symbols and vocabulary and uses them appropriately.
- Labels consistently and accurately graphs and diagrams.
- Specifies the units of measure when labeling.
- Calculates accurately and efficiently.
- Pursues a level of precision appropriate to the context of the problem.

#### MP 7 Look for and make use of structure.
- Looks for, identifies, develops and generalizes patterns and relationships.
- Makes connections to prior mathematical knowledge to solve new problems.
- Breaks down complex problems into manageable parts.
- Views complicated quantities both as single objects or compilations of several objects and uses operations to make sense of problems.

#### MP 8 Look for and express regularity in repeated reasoning.
- Notices repeated calculations and looks for general methods and shortcuts to solve a problem.
- Identifies patterns to develop algorithm, formula, or calculation.
- Evaluates reasonableness of intermediate and final results.
Smarter Balanced Assessment Consortium **Achievement Level Descriptors**

- Use the definitions of trigonometric ratios for acute angles and right angles (SBAC Claim 1, evidence required #1).
- Use similar triangles to define and determine trigonometric ratios in right triangles (SBAC Claim1, evidence required #2).
- Explain and use the relationship between the sine and cosine of complementary angles (SBAC Claim 1, evidence required #3).
- Use the Pythagorean Theorem and trigonometric ratios to solve problems involving right triangles in mathematical and real-world context (SBAC Claim 1, evidence required #4).
- Use the Pythagorean Theorem to solve unfamiliar problems with minimal scaffolding involving right triangles (SBAC ALD Level 3*).
- Use trigonometric ratios to find missing angles or sides of a given right triangle with minimal scaffolding (SBAC ALD Level 3*).
- Use the sine and cosine of complementary angles to find missing angles or sides of a given right triangle with minimal scaffolding (SBAC ALD Level 3*).
- Solve unfamiliar, complex, or multi-step problems involving right triangles (SBAC ALD Level 4*).

Students will also be assessed through Claim 1 and Claim 2 on this cluster of standards. For more information on the assessment of this cluster, please read the [SBAC Claim1 and Claim 2 Assessment Item Specifications](#).

<table>
<thead>
<tr>
<th>RANGE ALD</th>
<th>Level 1 students should be able to identify trigonometric ratios and use the Pythagorean Theorem to solve for the missing side in a right triangle in familiar real-world or mathematical contexts with scaffolding.</th>
<th>Level 2 students should be able to define trigonometric ratios and should know the relationship between the sine and cosine of complementary angles. They should be able to use the Pythagorean Theorem in unfamiliar problems and trigonometric ratios in familiar problems to solve for the missing side in a right triangle with some scaffolding.</th>
<th>Level 3 students should be able to use the Pythagorean Theorem, trigonometric ratios, and the sine and cosine of complementary angles to solve unfamiliar problems with minimal scaffolding involving right triangles, finding the missing side or missing angle of a right triangle.</th>
<th>Level 4 students should be able to solve unfamiliar, complex, or multi-step problems without scaffolding involving right triangles.</th>
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<tbody>
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<td>Target 0: Define trigonometric ratios and solve problems involving right triangles.</td>
<td>Level 1 students should be able to identify trigonometric ratios and use the Pythagorean Theorem to solve for the missing side in a right triangle in familiar real-world or mathematical contexts with scaffolding.</td>
<td>Level 2 students should be able to define trigonometric ratios and should know the relationship between the sine and cosine of complementary angles. They should be able to use the Pythagorean Theorem in unfamiliar problems and trigonometric ratios in familiar problems to solve for the missing side in a right triangle with some scaffolding.</td>
<td>Level 3 students should be able to use the Pythagorean Theorem, trigonometric ratios, and the sine and cosine of complementary angles to solve unfamiliar problems with minimal scaffolding involving right triangles, finding the missing side or missing angle of a right triangle.</td>
<td>Level 4 students should be able to solve unfamiliar, complex, or multi-step problems without scaffolding involving right triangles.</td>
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<tr>
<td>THRESHOLD ALD</td>
<td>Similarity, Right Triangles, and Trigonometry Target 0</td>
<td>The student who just enters Level 2 should be able to:</td>
<td>The student who just enters Level 3 should be able to:</td>
<td>The student who just enters Level 4 should be able to:</td>
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| Level 1 students should be able to identify trigonometric ratios and use the Pythagorean Theorem to solve for the missing side in a right triangle in familiar real-world or mathematical contexts with scaffolding. | Use the Pythagorean Theorem in unfamiliar problems to solve for the missing side in a right triangle with some scaffolding. | Use trigonometric ratios and the sine and cosine of complementary angles to find missing angles or sides of a given right triangle with minimal scaffolding. | Solve right triangle problems with multiple stages and in compound figures without scaffolding. |}

This document is a draft and will continue to develop as we learn more about the Common Core State Standards and the SBAC assessment.
Vocabulary

Mathematically proficient students communicate precisely by engaging in discussions about their reasoning using appropriate mathematical language. Students should learn the following terms with increasing precision within the cluster. The **bolded** terms will be used on Smarter Balanced assessment items.

<table>
<thead>
<tr>
<th>Adjacent side</th>
<th>Hypotenuse</th>
<th>Side</th>
</tr>
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<tbody>
<tr>
<td>Angle of depression</td>
<td>Indirect Measurement</td>
<td>Similar figures</td>
</tr>
<tr>
<td>Angle of elevation</td>
<td>Inverse Tangent</td>
<td>Slope</td>
</tr>
<tr>
<td>Complementary angles</td>
<td>Opposite side</td>
<td>Sine</td>
</tr>
<tr>
<td>Conjecture</td>
<td>Proportion</td>
<td>Slope</td>
</tr>
<tr>
<td><strong>Cosine</strong></td>
<td><strong>Pythagorean Theorem</strong></td>
<td><strong>Tangent</strong></td>
</tr>
<tr>
<td>Geometric Mean</td>
<td><strong>Right Triangle</strong></td>
<td><strong>Trigonometry</strong></td>
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<td></td>
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<td><strong>Trigonometric ratio</strong></td>
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**Standard G.SRT.5** Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

See [High School Flip Book](#) page 166 for explanations and examples of this standard.

**Learning Objectives**

- Use similarity theorems to develop relationships for sine, cosine, and tangent ratios.
- Apply the relationship of the side ratios for special right triangles to trigonometric ratios.
- Derive the relationship of the side ratios for special right triangles.
- Use ratios of special of right triangles to solve for exact values of missing side lengths and angles.

**Connections to Prior Learning**

7.G.2 Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

8.G.2 Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.

See [Math 8 Transformations test](#) for prior learning experiences.

<table>
<thead>
<tr>
<th>Curricular Material Connections</th>
<th>Additional Resources/Technology Resources</th>
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| Discovering Geometry textbook loosely addresses this standard in section 12.1. There is a short description on page 620. | [Math Open Reference](#) (visual resources)  
Patterns in Slope Triangles (adapted by Renton High School)  
Similarity and Right Triangle Trigonometry module lesson 6.8 (Mathematics Vision Project)  
Mathematics Vision Project Modules and Teacher Notes site www.betterlesson.com  
Geometry Common Core teacher site (objectives, content learning, tasks) |

This document is a draft and will continue to develop as we learn more about the Common Core State Standards and the SBAC assessment.
### Domain: Similarity, Right Triangles, and Trigonometry (G.SRT)

#### Right Triangle Relationships and Trigonometry Unit

**Standard G.SRT.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.

See [High School Flip Book](#) page 167-168 for explanations and examples of this standard.

### Learning Objectives

- Use definitions of trigonometric ratios for acute angles in a right triangle (SBAC [Claim 1, evidence required #1](#))
- Use similar triangles to define and determine trigonometric ratios in right triangles (SBAC [Claim 1, evidence required #2](#))
- Define sine, cosine, tangent, arcsine, arccosine, and arctangent.
- Accurately label the sides of right triangles as related to an acute angle.
- Use Angle-Angle criterion of similar triangles to justify trigonometric ratios.
- Understand that the value of the trigonometric ratios will stay the same, regardless of side length, as long as the triangles are similar.
- Use trigonometric ratios to find missing side lengths and angles of right triangles.

### Connections to Prior Learning

**8.G.6** Explain a proof of the Pythagorean Theorem and its converse.

**8.G.7** Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

**8.G.8** Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

See [Math 8 Pythagorean Theorem assessment](#) for prior learning expectation.
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<td>Pythagoras by Proportion (adapted from Mathematics Vision Project Module 6)</td>
</tr>
<tr>
<td><strong>Section 12.1 is missing:</strong></td>
<td>Math Open Reference (visual resources)</td>
</tr>
<tr>
<td>• Use similar triangles to define and determine trig ratios</td>
<td>Patterns in Slope Triangles (adapted by Renton High School)</td>
</tr>
<tr>
<td>• Define arcsine, arccosine, and arctangent</td>
<td>Similarity and Right Triangle Trigonometry module lesson 6.8, 6.9 and 6.10 (Mathematics Vision Project)</td>
</tr>
<tr>
<td>• Use Angle-Angle criterion of similar triangles to justify trigonometric ratios</td>
<td>Discovering Special Right Triangles task (Georgia DOE)</td>
</tr>
<tr>
<td>• Understand that the value of trig ratios will stay the same, regardless of side length, as long as the triangles are similar</td>
<td>Intro to Sine and Cosine (Renton HS)</td>
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<tr>
<td>See Additional Resources for suggested supplemental resources.</td>
<td>Intro to Trig module (Arlington Algebra Project-OER)</td>
</tr>
<tr>
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<td>Similar Right Triangles and Geometric Mean PowerPoint (wsfcs.k12.nc.us)</td>
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<td>Similarity and Trig Module (<a href="http://www.bse.ph">www.bse.ph</a>)</td>
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<td>Trig Angle Hunt task (Renton HS)</td>
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<td></td>
<td>Trig Ratios and their Inverses (Lindbergh HS)</td>
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**Standard G.SRT.7** Explain and use the relationship between the sine and cosine of complementary angles.

See [High School Flip Book page 169](#) for explanations and examples of this standard.

### Learning Objectives

- Use the relationship between the sine and cosine of complementary angles ([SBAC Claim 1, required evidence #3](#)).
- Explain how the sine and cosine of complementary angles are related to each other ([SBAC Claim 1 required evidence #3](#)).
- Use the sine and cosine of complementary angles to find missing angles or sides of a given triangle with minimal scaffolding ([SBAC ALD Level 3*](#)).

### Connections to Prior Learning

**8.G.6** Explain a proof of the Pythagorean Theorem and its converse.

**8.G.7** Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

**8.G.8** Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

See [Math 8 Pythagorean Theorem assessment](#) for prior learning expectation.

### Curricular Material Connections

**This standard is missing** from Discovering Geometry text. See Additional Resources for suggested supplemental resources

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<tr>
<td><a href="#">Similarity and Right Triangle Trigonometry module</a> lesson 6.9 (Mathematics Vision Project)</td>
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<tr>
<td><a href="#">Sine and Cosine of Complementary Angles</a> (Illustrative Mathematics)</td>
</tr>
<tr>
<td><a href="#">Create Your Own Triangles Learning</a> Task (Georgia DOE)</td>
</tr>
<tr>
<td><a href="#">Discovering Trigonometric Ratio</a> Relationships (Georgia DOE)</td>
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<tr>
<td><a href="#">Mathematics Vision Project Modules and Teacher Notes</a> site</td>
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### Standard G.SRT.8

Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. ★

See [High School Flip Book](#) page 170 for explanations and examples of this standard.

### Standard G.MG.1

Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*

See [High School Flip Book](#) pages 197-198 for explanations and examples of this standard.

### Standard G.MG.3

Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).*

See [High School Flip Book](#) page 200-201 for explanations and examples of this standard.

### Learning Objectives

#### G.SRT.8
- Use the Pythagorean Theorem and trigonometric ratios to solve problems involving right triangles in mathematical and real-world context (SBAC Claim 1, evidence required #4).
- Use the Pythagorean Theorem to solve multi-step contextual problems with minimal scaffolding involving right triangles (SBAC ALD Level 3)
- Use trigonometric ratios to find missing angles or sides of a given triangle with minimal scaffolding in real-life problems (SBAC ALD Level 3*)
- Recognize which trigonometric ratio could be used to solve right triangles in real-world problems.

#### G.MG.1
- Identify right triangles in the everyday environment.
- Solve real-world problems that model trigonometric ratios for acute angles (Appendix A description)

#### G.MG.3
- Investigate and model design problems using scaled images.
- Solve real-world problems that model trigonometric ratios for acute angles.

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### Connections to Prior Learning

**8.G.6** Explain a proof of the Pythagorean Theorem and its converse.

**8.G.7** Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

**8.G.8** Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

See [Math 8 Pythagorean Theorem assessment](#) for prior learning expectation.

### Curricular Material Connections

Discovering Geometry text addresses this standard in section 12.2. Section 9.4 uses real-world problems with Pythagorean Theorem and page 623 lightly covers inverse trigonometry.

**Section 12.2 is missing:**
- Recognize which trigonometric ratio could be used to solve right triangles in real-world problems

Connections need to be made between this standard and MG.1 and MG.3.

See Additional Resources for suggested supplemental resources.

### Additional Resources/Technology Resources

- [Similarity and Right Triangle Trigonometry module](#) lesson 6.10 and 6.11 (Mathematics Vision Project)
- [Ask the Pilot](#) task (Illustrative Mathematics)
- [Neglecting the Curvature of the Earth](#) task (Illustrative Mathematics)
- [How Tall is It?](#) Task (HCPSS)
- [Angles of Elevation and Depression](#) (Renton HS)
- [Applying Trig Ratios](#) (Lindbergh HS)
- [Mt. Whitney to Death Valley Task](#) MG.3 task (Illustrative Mathematics)
- [Polygon Area](#) (Renton HS)
- [Right Triangle Trig Pictures](#) (Lindbergh HS)
- [Right Triangle Trig Practice](#) (Lindbergh HS)
- [Trig Applications](#) (Renton HS)
- [Trig Ratio Practice with Applications](#) (Lindbergh HS)
- [Seven Circles](#) MG.3 task (Illustrative Mathematics)
- [Finding Right Triangles in Your Environment Learning Task](#) for MG.1 (Georgia DOE)
- [Satellite](#) task for MG.3 (Illustrative Mathematics)
- [Mathematics Vision Project Modules and Teacher Notes](#) site
*SBAC ALD Level 3 or Level 4 means Smarter Balanced Achievement Level Descriptors for entering into a Level 3 or Level 4 for Claim 1 Targets. Claim 1 targets cover “Concepts and Procedures” where students can explain and apply mathematical concepts and interpret and carry out mathematical procedures with precision and fluency.

Additional resources can be found at http://staff.rentonschools.us/renton/secondary-math/geometry-ccss-m-resources or by clicking on the above hyperlinks from within the document.

The following resources were used to create this curriculum guide: High School Common Core State Standards Flip Book compiled by Trish Hart and Modeling Progression document by Common Core Standards Writing Team. (2013, July 4).

A further unpacking of the Geometry Common Core State Standards by Hung-Hsi Wu (2013) titled “Teaching Geometry in Grade 8 and High School According to the Common Core Standards” can be found at http://math.berkeley.edu/~wu/CCSS-Geometry.pdf.