

# Unpacked South Dakota State Mathematics Standards

**Purpose:** In order for students to have the best chance of success, standards, assessment, curriculum resources, and instruction must be aligned in focus, coherence, and rigor. Unpacked standards documents are intended to help align instruction to the focus, coherence, and rigor of the South Dakota State Mathematics Standards. The standards have been organized in clusters as they are not so much built from topics, but rather woven out of progressions. Not all content in a given grade is emphasized equally in the mathematics standards. Some clusters require greater emphasis than others based on the depth of the ideas, the time that they take to master, and/or their importance to future mathematics or the demands of college and career readiness. To say that some things have greater emphasis is not to say that anything in the standards can safely be neglected in instruction. Neglecting standards will leave gaps in student skill and understanding and may leave students unprepared for the challenges of a later grade.

<b>Domain: Functions</b>		<b>Grade Level: 4th Year</b>
<p><b>HS4.F.TF.A Cluster: Extend the domain of trigonometric functions using the unit circle.</b>          Students will move beyond right triangle definitions and begin to extend trigonometric definitions to obtuse triangles using the unit circle.</p>		
<p><b>HS4.F.TF.A In a precalculus class this is a MAJOR cluster.</b> <i>Students should spend the large majority of their time (65-85%) on the major work of the grade. Supporting work and, where appropriate, additional work should be connected to and engage students in the major work of the grade.</i></p>		
<p><b>F.TF.3</b> Use special triangles to determine geometrically the values of sine, cosine, tangent for <math>\pi/3</math>, <math>\pi/4</math> and <math>\pi/6</math>, and use the unit circle to express the values of sine, cosine, and tangent for <math>\pi-x</math>, <math>\pi+x</math>, and <math>2\pi-x</math> in terms of their values for <math>x</math>, where <math>x</math> is any real number.</p> <p><b>F.TF.4</b> Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.</p>		
<b>Aspects of Rigor of Student Learning:</b> (Conceptual, Procedural, and/or Application)		
<p><b>F.TF.3</b> Use special triangles to determine geometrically the values of sine, cosine, tangent for <math>\pi/3</math>, <math>\pi/4</math> and <math>\pi/6</math>, and use the unit circle to express the values of sine, cosine, and tangent for <math>\pi-x</math>, <math>\pi+x</math>, and <math>2\pi-x</math> in terms of their values for <math>x</math>, where <math>x</math> is any real number.</p>		
<b>Conceptual Understanding</b>	<b>Procedural Fluency</b>	<b>Application</b>
<p>Identify the side length ratios of special right triangles on a unit circle (<math>\pi/3</math>, <math>\pi/4</math> and <math>\pi/6</math>).</p> <p>Use side length ratios to calculate trigonometric function values for special angles.</p> <p>Use reference angles to extend special right triangles to all quadrants.</p> <p>Extend angle measures beyond one revolution to identify the periodicity and symmetry of a sinusoidal function.</p>	<p>Create special-case right triangles within a unit circle in order to use trigonometric ratios to solve for unknown sides or angles.</p> <p>Calculate values of sine, cosine, and tangent for angles that are multiples of <math>\pi/3</math>, <math>\pi/4</math> and <math>\pi/6</math></p>	
<p><b>F.TF.4</b> Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.</p>		
<b>Conceptual Understanding</b>	<b>Procedural Fluency</b>	<b>Application</b>
<p>Reference angles can be used to find trigonometric values of any multiple of</p>		

<p><math>\pi/3</math>, <math>\pi/4</math> and <math>\pi/6</math>.</p> <p>One revolution of the unit circle is equivalent to one period for sine and cosine. The period is <math>2\pi</math> radians or <math>360^\circ</math>. As one continues with multiple revolutions of the unit circle, coterminal angles share the same sine and cosine values.</p> <p>Sine and tangent functions are odd functions and have origin symmetry, and cosine is an even function and has y-axis symmetry.</p>		
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**Enacting the Mathematical Practices - Evidence of Students Engaging in the Practices**

1. **Make sense of problems and persevere in solving them.**
2. **Reason abstractly and quantitatively.**
3. **Construct viable arguments and critique the reasoning of others.**
4. **Model with mathematics.**
5. **Use appropriate tools strategically.**
6. **Attend to precision.**
7. **Look for and make use of structure.**
  - Special right triangles and reference angles allow students to see structure in the unit circle.
8. **Look for and express regularity in repeated reasoning.**
  - Trigonometric functions are periodic in nature and allow students to utilize patterns in problem solving.

**Vertical and Horizontal Coherence and Learning Progressions**

<i>Previous Learning Connections</i>	<i>Current Learning Connections</i>	<i>Future Learning Connections</i>
<p>Students have used similar triangles as an application of geometry and proportions when using a scale factor and dilation. Students have also defined trigonometric ratios in geometry using the acute angles of right triangles building on the ideas of similarity. Students will have explored the Pythagorean theorem to find missing side lengths of a right triangle.</p>	<p>Students will move beyond right triangle definitions and begin to study applications in trigonometry that extend trigonometric definitions to obtuse triangles using the unit circle.</p>	<p>Defining trigonometric functions using a unit circle creates opportunities for students to explore concepts such as positive and negative angle measures, finding the value of a trigonometric function of any real number, periodicity and generalizations of trigonometric properties so they may be proved as identities. In order to model periodic functions over time, students must go beyond the domain <math>[0, \pi/2]</math> used in geometry.</p>

**Vocabulary (key terms and definitions)**

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| <ul style="list-style-type: none"> <li>• Special triangles (30-60-90 triangle and 45-45-90 triangle)</li> <li>• Sine function</li> <li>• Cosine function</li> <li>• Tangent function</li> <li>• Unit circle</li> <li>• Reference angles</li> </ul> | <ul style="list-style-type: none"> <li>• Radian</li> <li>• Symmetry</li> <li>• Odd and Even functions</li> <li>• Period</li> <li>• Periodic function</li> </ul> |
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### Relevance, Explanations, and Examples:

Relationships in special-case triangles can be used to find the trigonometric values of angles that are multiples of  $\pi/3$ ,  $\pi/4$  and  $\pi/6$ .

Students should be able to graph select coordinates of the unit circle with respect to the angle (angle, y-coordinate) or (angle, x-coordinate). Students should identify that these graphs are the sine and cosine functions.

