# Curriculum and Instruction – Mathematics

## Quarter 2

## Pre-Calculus

| Quarter 1 | Quarter 2 | | Quarter 3 | | Quarter 4 | |
|---|---|---|---|---|---|---|
| Various Functions & Their Graphs, Polynomials & Polynomial Functions, Inverse Functions | Trigonometric Functions and Their Graphs, Unit Circle, Inverse Trigonometric Functions, Law of Sines, Law of Cosines, Trigonometric Identities | | Exponential and Logarithmic Functions, Conic Sections | | Systems of Equations and Matrices, Polar Coordinates and Complex Numbers, Sequences and Series, Limits and Introduction to Integrals | |
| **August 6 2018 – October 5, 2018** | **October 15, 2018 – December 19, 2018** | | **January 7, 2019 – March 8, 2019** | | **March 18, 2019 – May 23, 2019** | |
| P.F.IF.A.1 | P. G.AT.A.1 | P.F.GT.A.8 | P.A.PE.A.1 | P.N.NE.A.2 | P. A. REI.A.1 | P.A.S.A.1 |
| P.F.IF.A.2 | P.G.AT.A.3 | P.G.TI.A.2 | P.A.PE.A.2 | | P. A. REI.A.2 | P.A.S.A.2 |
| P.F.IF.A.4 | P.G.AT.A.5 | | P. A.C.A.2 | | P. N. VM.A.1 | P.A.S.A.3 |
| P.F.IF.A.5 | P.G.AT.A.6 | | P. A.C.A.3 | | P. N. VM.A.2 | P.A.S.A.4 |
| P.F.IF.A.6 | P.F.TF.A.1 | | P.F.IF.A.2 | | P. N. VM.A.3 | P.A.S.A.5 |
| P.F.IF.A.7 | P.F.TF.A.2 | | P.F.IF.A.3 | | P. N. VM.B.4 | P. N. VM.C.13 |
| P.F.BF.A.1 | P.F.GT.A.3 | | P.F.IF.A.5 | | P. N. VM.B.5 | Calculus C.F.LF.A.2 |
| P.F.BF.A.3 | P.F.GT.A.4 | | P.S.MD.A.1 | | P. N. VM.B.6 | Calculus C.F.LF.A.3 |
| P.F.BF.A.5 | P.F.GT.A.5 | | P.S.MD.A.2 | | P.G.PC.A.1 | |
| P.F.BF.A.6 | P.F.GT.A.6 | | P.S.MD.A.3 | | P.G.PC.A.2 | |
| P.N.CN.B.7 | P.F.GT.A.7 | | P.N.NE.A.1 | | P.G.PC.A.3 | |
| | | | | | | |

[Tennessee Academic Standards for Mathematics](Tennessee Academic Standards for Mathematics)

## Introduction

Destination 2025, Shelby County Schools' 10-year strategic plan, is designed not only to improve the quality of public education, but also to create a more knowledgeable, productive workforce and ultimately benefit our entire community.

**What will success look like?**



In order to achieve these ambitious goals, we must collectively work to provide our students with high quality, college and career ready aligned instruction. The Tennessee State Standards provide a common set of expectations for what students will know and be able to do at the end of a grade.  The State of Tennessee provides two sets of standards, which include the Standards for Mathematical Content and The Standards for Mathematical Practice. The Content Standards set high expectations for all students to ensure that Tennessee graduates are prepared to meet the rigorous demands of mathematical understanding for college and career. The eight Standards for Mathematical Practice describe the varieties of expertise, habits of mind, and productive dispositions that educators seek to develop in all students. The Tennessee State Standards also represent three fundamental shifts in mathematics instruction: **focus, coherence and rigor**.



Tennessee Academic Standards for Mathematics
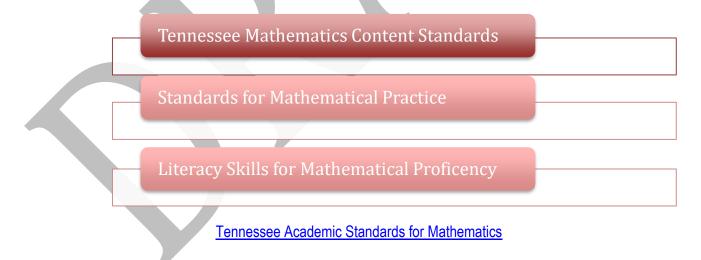
The **Standards for Mathematical Practice** describe varieties of expertise, habits of minds and productive dispositions that mathematics educators at all levels should seek to develop in their students. These practices rest on important National Council of Teachers of Mathematics (NCTM) "processes and proficiencies" with longstanding importance in mathematics education. Throughout the year, students should continue to develop proficiency with the eight Standards for Mathematical Practice. The following are the eight Standards for Mathematical Practice:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of them.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

This curriculum map is designed to help teachers make effective decisions about what mathematical content to teach so that ultimately our students can reach Destination 2025. Throughout this curriculum map, you will see resources as well as links to tasks that will support you in ensuring that students are able to reach the demands of the standards in your classroom. In addition to the resources embedded in the map, there are some high-leverage resources around the content standards and mathematical practice standards that teachers should consistently access. For a full description of each, click on the links below.

Tennessee Mathematics Content Standards

Standards for Mathematical Practice

Literacy Skills for Mathematical Proficiency

Tennessee Academic Standards for Mathematics

# Structure of the Standards

Structure of the TN State Standards include:

- **Content Standards** - Statements of what a student should know, understand, and be able to do.

- **Clusters** - Groups of related standards. Cluster headings may be considered as the big idea(s) that the group of standards they represent are addressing. They are therefore useful as a quick summary of the progression of ideas that the standards in a domain are covering and can help teachers to determine the focus of the standards they are teaching.

- **Domains** - A large category of mathematics that the clusters and their respective content standards delineate and address. For example, Number and Operations – Fractions is a domain under which there are a number of clusters (the big ideas that will be addressed) along with their respective content standards, which give the specifics of what the student should know, understand, and be able to do when working with fractions.

- **Conceptual Categories** – The content standards, clusters, and domains in the 9th-12th grades are further organized under conceptual categories. These are very broad categories of mathematical thought and lend themselves to the organization of high school course work. For example, Algebra is a conceptual category in the high school standards under which are domains such as Seeing Structure in Expressions, Creating Equations, Arithmetic with Polynomials and Rational Expressions, etc.

[Tennessee Academic Standards for Mathematics](#)

# How to Use the Maps

## Overview
An overview is provided for each quarter and includes the topics, focus standards, intended rigor of the standards and foundational skills needed for success of those standards.

**Your curriculum map contains four columns that each highlight specific instructional components. Use the details below as a guide for information included in each column.**

## Tennessee State Standards
TN State Standards are located in the left column. Each content standard is identified as Major Content or Supporting Content (for Algebra I, Algebra II & Geometry only). A key can be found at the bottom of the map.

## Content
This section contains learning objectives based upon the TN State Standards. Best practices tell us that clearly communicating measurable objectives lead to greater student understanding. Additionally, essential questions are provided to guide student exploration and inquiry.

## Instructional Support & Resources
District and web-based resources have been provided in the Instructional Support & Resources columns. You will find a variety of instructional resources that align with the content standards. The additional resources provided should be used as needed for content support and scaffolding. The inclusion of vocabulary serves as a resource for teacher planning and for building a common language across K-12 mathematics. One of the goals for Tennessee State Standards is to create a common language, and the expectation is that teachers will embed this language throughout their daily lessons.

Tennessee Academic Standards for Mathematics

# Topics Addressed in Quarter

- **Trigonometric Functions and Their Graphs**
- **Unit Circle**
- **Inverse Trigonometric Functions**
- **Law of Sines**
- **Law of Cosines**
- **Trigonometric Identities**

# Overview

In this quarter students build upon their understanding, from Algebra 2, of the trigonometric functions. They use special right triangles to determine the x- and y-coordinates of angles on the unit circle and investigate how the symmetry of the unit circle helps to extend knowledge to angles outside of the first quadrant. Students use that information to define sine and cosine and investigate and solve inverse trigonometric functions that occur in the real-world.

| TN STATE STANDARDS | CONTENT | INSTRUCTIONAL SUPPORT & RESOURCES |
|---|---|---|
| GLENCOE - Chapter 4: Trigonometric Functions   Chapter 5: Trigonometric Identities & Equations<br>SULLIVAN – Chapter 6: Trigonometric Functions   Chapter 7: Analytic Trigonometry   Chapter 8: Applications of Trigonometric Functions<br>(Allow approximately 6 weeks for instruction, review, and assessment) | | |
| **Domain:** Applied Trigonometry<br><br>**Cluster:** Use trigonometry to solve problems. ★<br><br><br>**P. G.AT.A.1** Use the definitions of the six trigonometric ratios as ratios of sides in a right triangle to solve problems about lengths of sides and measures of angles. | **Essential Question(s):**<br>- What are the six trigonometric functions for the acute angles in a right triangle?<br>- Why are the trigonometric ratios in similar triangles equal?<br>- How is trigonometry used to solve right triangles, including real-world applications?<br><br>**Objective(s):**<br>- Students will find the values of trigonometric functions for acute angles of right triangles.<br>- Students will solve right triangles. | **Glencoe**<br>4-1: Right Angle Trigonometry<br><br>**Sullivan**<br>8.1: Right Angle Trigonometry; Applications<br>**Task(s):**<br>Illustrative Math: Defining Trig Ratios<br>Edutoolbox: Making Right Triangles<br>Edutoolbox: Relating Trigonometric Functions<br><br>**Additional Resources:**<br>Trigonometry Videos<br>Better Lesson: Problem Solving with Isosceles Triangles and Circles |

**Vocabulary:** trigonometric ratios trigonometric functions, sine, cosine, tangent cosecant, secant, cotangent reciprocal function inverse trigonometric function inverse sine, inverse cosine inverse tangent, angle of elevation angle of depression, solve a right triangle

**Writing in Math:**
Explain why the six trigonometric functions are transcendental functions.

Explain how to determine the length of an unknown side of a right triangle given one acute angle and one side length. Write a general statement explaining how to select which trigonometric function to use to solve the problem.

Tennessee Academic Standards for Mathematics

| TN STATE STANDARDS | CONTENT | INSTRUCTIONAL SUPPORT & RESOURCES | |
|---|---|---|---|
| **Domain:** Trigonometric Functions<br>**Cluster:** Extend domain of trig functions using the unit circle.<br>**P.F.TF.A.1** Convert from radians to degrees and from degrees to radians.<br><br>**Domain:** Applied Trigonometry<br>**Cluster:** Use trigonometry to solve problems.<br>**P.G.AT.A.3** Derive and apply the formulas for the area of sector of a circle. | **Essential Question(s):**<br>• How do trigonometric and circular functions model real-world problems and their solutions?<br>• How are the circular functions related to the trigonometric functions?<br><br>**Objective(s):**<br>• Students will convert degree measures of angles to radian and vice versa.<br>• Students will derive and apply the formula for the area of a sector of a circle. | **Glencoe**<br>4-2: *Degrees and Radians*<br><br>**Sullivan**<br>6.1: *Angles and Their Measures*<br><br>**Task(s):**<br>Discover Radians!<br>Pizza Sector<br><br>**Additional Resources:**<br>Khan Academy: Radians and Degrees<br>Trigonometry Videos<br><br>Mathguide.com: Trigonometric Angles<br>CPalms.org: Deriving the Sector Area Formula<br>NCTM Illuminations: Graphs from the Unit Circle<br>NCTM Illuminations: Rolling into Radians<br>Better Lesson: Advantages of Radian Measures | **Vocabulary:** vertex, initial side, terminal side, standard position, radian, co-terminal angles, linear speed, angular speed, sector<br><br>**Writing in Math:**<br>Compare and contrast degree and radian measures. You may use a Venn diagram or other compare/contrast graphic organizer. |
| **Domain:** Trigonometric Functions<br>**Cluster:** Extend the domain of trigonometric functions using the unit circle.<br><br>**P.F.TF.A.2** Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi-x$, $\pi+x$, and $2\pi-x$ in terms of their values for $x$, where $x$ is any real number. | **Essential Question(s):**<br>• How can special right triangles help us find the coordinates of certain angles on the unit circle?<br><br>**Objective(s):**<br>• Students will find the values of trigonometric functions for any angle, including the unit circle. | **Glencoe**<br>4-3: Trigonometric Functions on the Unit Circle<br><br>**Sullivan**<br>6.2: Trigonometric Functions: Unit Circle Approach<br><br>**Task(s):**<br>Trigonometric Functions Tasks<br>Utah Education Network: Off on a Tangent<br><br>**Additional Resources:**<br>Trigonometry Videos | **Vocabulary:** quadrantal angle, reference angle, unit circle, circular function, periodic function, period<br><br>**Writing in Math:**<br>Make a conjecture as to the periods of the secant, cosecant and cotangent functions. Explain your reasoning. |

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| TN STATE STANDARDS | CONTENT | INSTRUCTIONAL SUPPORT & RESOURCES | |
|---|---|---|---|
| | | Engage NY Lesson: Special Triangles and the Unit Circle<br>Shmoop.com: Trigonometric Functions<br>Math Warehouse: Unit Circle Game<br>Khan Academy: Trigonometric Ratios and Similarity | |
| **Domain:** Graphing Trigonometric Functions<br>**Cluster:** Model periodic phenomena with trigonometric functions. ★<br><br>**P.F.GT.A.3** Graph the six trigonometric functions and identify characteristics such as period, amplitude, phase shift and asymptotes.<br>. | **Essential Question(s):**<br><br>• How is the domain and range of the six trigonometric functions determined?<br>• What is a phase shift?<br>• How do amplitudes, periods, phase shifts, vertical shifts and co-functions relate to the graphs of translated sine and cosine functions?<br>• Which trigonometric functions have asymptotes and why?<br><br><br>**Objective(s):**<br><br>• Graph sine and cosine functions and their transformations and determine period, amplitude, phase shift, and midline.<br>   Graph tangent and reciprocal trigonometric functions. | **Glencoe**<br>4-4: Graphing Sine and Cosine Functions<br>4-5: Graphing Other Trigonometric Functions<br><br>**Sullivan**<br>6.3: Properties of Trigonometric Functions<br>6.4: Graphs of Sine and Cosine Functions<br>6.5: Graphs of Tangent, Cotangent, Cosecant, and Secant Functions<br><br>**Tasks:**<br>Graphs of Sine and Cosine<br>(see SCS Math Tasks (Precalculus))<br><br><br>**Additional Resources:**<br>Trigonometry Videos<br>Engage NY: Properties of Trig Functions<br>Graphing Sine & Cosine Functions<br>Off on a Tangent<br>Khan Academy: The Graphs of Sine, Cosine and Tangent<br>Investigating Trigonometric Graphs<br><br>NCTM Illuminations: Trigonometric Graphing Interactive<br><br>Better Lesson: Graphs of Sine and Cosine<br>Better Lesson: Modeling Average Temperature with Trigonometry | **Vocabulary:** sinusoid, amplitude, frequency, phase shift, vertical shift, midline<br><br>**Writing in Math:**<br>What are the basic properties of tangent, cotangent, cosecant and secant graphs? |

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| TN STATE STANDARDS | CONTENT | INSTRUCTIONAL SUPPORT & RESOURCES | |
|---|---|---|---|
| | | Khan Academy: Intro to Amplitude, Midline, & Extrema of Sinusoidal Functions | |
| **GLENCOE - Chapter 4: Trigonometric Functions   Chapter 5: Trigonometric Identities & Equations**<br>**SULLIVAN – Chapter 7: Analytic Trigonometry**<br>**(Allow approximately 3 weeks for instruction, review, and assessment)** | | |
| **Domain:** Graphing Trigonometric Functions<br><br>**Cluster:** Model periodic phenomena with trigonometric functions. ★<br><br>**P.F.GT.A.4** Find values of inverse trigonometric expressions (including compositions), applying appropriate domain and range restrictions.<br>**P.F.GT.A.5** Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.<br>**P.F.GT.A.6** Determine the appropriate domain and corresponding range for each of the inverse trigonometric functions.<br>**P.F.GT.A.7** Graph the inverse trigonometric functions and identify their key characteristics. | **Essential Questions:**<br>• How can you compare the graphs of the sine, cosine, tangent functions and their inverses?<br>• Since the trigonometric functions are not one-to-one, how can the domain be restricted to graph the inverse functions?<br>• How are inverse trigonometric functions used to find angles in real-world problems?<br><br>**Objectives:**<br>• Students will evaluate and graph inverse trigonometric functions.<br>• Students will determine the coordinates of the points on an inverse trigonometric function from a table of values.<br>• Students will determine the domain for the inverse sine, inverse cosine, and inverse tangent functions. | **Glencoe**<br>4-6: Inverse Trigonometric Functions<br>**Sullivan**<br>7.1: The Inverse Sine, Cosine, and Tangent Functions<br>7.2: The Inverse Trigonometric Functions (Continued)<br>**Tasks:**<br>Illustrative Math: Foxes and Rabbits 2<br>Math Vision Project: "Sine" Language- A Solidifying Understanding Task (p. 12 if viewing from a computer, p. 8 if printed).<br><br>**Additional Resources:**<br>Trigonometry Videos<br>Engage NY: Revisiting the Graphs of the Trigonometric Functions<br>Engage NY: Inverse Trig Functions<br>Khan Academy: Inverse Trigonometric Functions<br>Cengage Learning: Inverse Trigonometric Functions | **Vocabulary:** arcsine function, arccosine function, arctangent function<br><br>**Writing in Math:**<br>Explain how the restrictions on the sine, cosine, and tangent functions dictate the domain and range of their inverse functions. |
| **Domain:** Graphing Trigonometric Functions<br>**Cluster:** Model periodic phenomena with trigonometric functions. ★ | **Essential Question(s):**<br>• What substitutions involving trigonometric identities need to be used for solving some trigonometric equations?<br>• How are algebraic operations used for | **Glencoe**<br>5-3: Solving Trigonometric Equations<br>**Sullivan**<br>7.7: Trigonometric Equations | **Vocabulary:** inverse trigonometric function<br>**Graphic Organizer:** Inverse Trigonometric Functions<br><br>**Writing in Math:** |

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| TN STATE STANDARDS | CONTENT | INSTRUCTIONAL SUPPORT &  RESOURCES | |
|---|---|---|---|
| **P.F.GT.A.8** Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. | solving trigonometric equations (including those in quadratic form)? <br><br> **Objective(s):** <br> • Students will solve trigonometric equations using algebraic techniques and using basic identities. | **Task(s):** <br> Inverse Trigonometric Functions <br> GSE: Inverse Trigonometric Functions <br><br> **Additional Resources:** <br> Trigonometry Videos <br> Engage NY: Modeling with Trigonometric Functions <br> Khan Academy: Using Inverse Trig Functions with a Calculator <br> Better Lesson: Modeling with Periodic Functions | Explain the difference in the techniques that are used when solving equations and verifying identities. |
| **Domain:** Trigonometric Identities <br> **Cluster:** Apply trigonometric identities to rewrite expressions and solve equations. ★ <br><br> **P.G.TI.A.2** Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems. | **Essential Questions:** <br> • How can I prove the addition formula for trigonometric functions? <br> • How can I prove the subtraction formula for trigonometric functions? <br> • How can algebraic properties be used to simplify trigonometric expressions and verify identities? <br> • <br> **Objectives:** <br> • Use sum and difference identities to evaluate trigonometric functions. <br> • Use sum and difference identities to solve trigonometric equations. <br> • Students will show how all of the sum and difference angle formulas can be derived from a single formula. | **Glencoe** <br> 5-4: Sum and Difference Identities <br> **Sullivan** <br> 7.4: Sum and Difference Formulas <br><br> **Tasks:** <br> GSE: Addition and Subtraction Formulas for Sine, Cosine and Tangent <br> (**Three tasks** - pp. 9-25 & 34-37; Double-angle task included) <br> Illustrative Math: Sum and Difference Angle Formulas <br> Illustrative Math:  Coordinates of Equilateral Triangles <br><br> **Additional Resources:** <br> Trigonometry Videos <br> Engage NY: Trigonometry Identity Proof <br> Engage NY: Prove Addition and Subtraction Formulas | **Vocabulary:**  reduction identity <br><br> **Writing in Math:** <br> Can a tangent sum or difference identity be used to solve any tangent reduction formula? Explain your reasoning. <br><br> Students will read a word problem and identify the language needed to create an algebraic representation in order to solve the problem. Students will write an explanation to justify their solution. <br><br> . |

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| TN STATE STANDARDS | CONTENT | INSTRUCTIONAL SUPPORT &  RESOURCES | |
|---|---|---|---|
| | | Khan Academy: Proof of the Cosine Angle Addition Identity  Khan Academy: Proof of the Sine Angle Addition Identity  Khan Academy: Trig Identity Reference Sheet | |
| **Domain**: Applied Trigonometry  **Cluster:** Use trigonometry to solve problems. ★  **P.G.AT.A.5** Prove the Laws of Sines and Cosines and use them to solve problems.  **P.G.AT.A.6** Understand and apply the Law of Sines (including the ambiguous case) and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant force). | **Essential Questions**:  • How is the area of a triangle found when two sides and the included angles are given?  • How are oblique triangles solved using the Law of Sines and the Law of Cosines?  • In real-world situations, such as navigation, surveying, etc., how can the Law of Sines of the Law of Cosines be used?  **Objective(s):**  • Students will solve oblique triangles using the Law of Cosines and the Law of Sines, including the ambiguous case. | **Glencoe**  4-7: The Law of Sines and the Law of Cosines  **Sullivan**  8.2: The Law of Sines  8.3: The Law of Cosines  **Tasks:**  GSE: Proving the Laws of Sines and Cosines (Two tasks - pp. 16-32)  G-SRT.D.11 Tasks (p. 6)  **Additional Resources:**  Trigonometry Videos  NCTM Illuminations: Law of Cosines  NCTM: Illuminations: Law of Sines  **Task(s)**  The Non-Right Triangle (pp.28-31)  Khan Academy: Law of Sines  Khan Academy: Law of Cosine | **Vocabulary:** oblique triangles, Law of Sines, ambiguous case, Law of Cosines, Heron's Formula  **Writing in Math:**  Explain the different circumstances in which you would use the Law of Cosines, the Law of Sines, the Pythagorean Theorem, and the trigonometric ratios to solve a triangle. |

Tennessee Academic Standards for Mathematics

| RESOURCE TOOLBOX |
|---|

| Textbook Resources | Standards | Videos |
|---|---|---|
| **Textbook Resources**<br>**Glencoe Precalculus © 2011**<br>http://connected.mcgraw-hill.com/connected/login.do<br><br>**Sullivan Precalculus: Enhanced with Graphing Utilities, 5e © 2009.** | **Standards**<br>Common Core Standards - Mathematics<br>Common Core Standards - Mathematics Appendix A<br>The Mathematics Common Core Toolbox<br>Common Core Lessons<br>Tennessee Standards for Mathematics | **Videos**<br>Khan Academy<br>Lamar University Tutorial<br>UCI Precalculus Instructional Videos |
| **Calculator**<br>Texas Instruments Education<br>Texas Instruments - Precalculus Activities<br>Casio Education<br>TI Emulator<br>Math Nspired | **Interactive Manipulatives**<br>http://www.ct4me.net/math_manipulatives_2.htm<br>Illuminations (NCTM)<br><br>**ACT**<br>ACT College & Career Readiness Mathematics Standards<br><br>**Tasks/Lessons**<br>UT Dana Center<br>Inside Math Tasks<br>Math Vision Project Tasks<br>Better Lesson<br>GSE Precalculus: Unit 1 Introduction to Trigonometric Functions<br>Edutoolbox.org (formerly TN Core)<br>GSE Precalculus: Unit 2 Trigonometric Functions<br>GSE Precalculus: Unit 4 Trigonometric Identities<br>**SCS Math Tasks (Precalculus)** | **Additional Sites**<br>http://functions.wolfram.com<br>http://www.opensourcemath.org<br>http://www.purplemath.com/<br>http://www.onlinemathlearning.com/math-word-problems.html<br>http://education.ti.com/calculators/downloads/US/Activities/Detail?id=9530<br>Better Lesson<br>Algebra Cheat Sheet<br>Trigonometry Cheat Sheet<br>Online Algebra and Trigonometry Tutorial<br>Study Tips for Math Courses<br>Graphic Organizers (9-12) |

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