

Tennessee Math Standards

Introduction

The Process

The Tennessee State Math Standards were reviewed and developed by Tennessee teachers for Tennessee schools. The rigorous process used to arrive at the standards in this document began with a public review of the then-current standards. After receiving 130,000+ reviews and 20,000+ comments, a committee composed of Tennessee educators spanning elementary through higher education reviewed each standard. The committee scrutinized and debated each standard using public feedback and the collective expertise of the group. The committee kept some standards as written, changed or added imbedded examples, clarified the wording of some standards, moved some standards to different grades, and wrote new standards that needed to be included for coherence and rigor. From here the standards went before the appointed Standards Review Committee to make further recommendations before being presented to the Tennessee Board of Education for final adoption.

The result is Tennessee Math Standards for Tennessee Students by Tennesseans.

Mathematically Prepared

Tennessee students have various mathematical needs that their K-12 education should address.

All students should be able to recall and use their math education when the need arises. That is, a student should know certain math facts and concepts such as the multiplication table, how to add, subtract, multiply, and divide basic numbers, how to work with simple fractions and percentages, etc. There is a level of procedural fluency that a student's K-12 math education should provide him or her along with conceptual understanding so that this can be recalled and used throughout his or her life. Students also need to be able to reason mathematically. This includes problem solving skills in work and non-work related settings and the ability to critically evaluate the reasoning of others.

A student's K-12 math education should also prepare him or her to be free to pursue post-secondary education opportunities. Students should be able to pursue whatever career choice, and its post-secondary education requirements, that they desire. To this end, the K-12 math standards lay the foundation that allows any student to continue further in college, technical school, or with any other post-secondary educational needs.

A college and career ready math class is one that addresses all of the needs listed above. The standards' role is to define what our students should know, understand, and be able to do mathematically so as to fulfill these needs. To that end, the standards address conceptual understanding, procedural fluency, and application.

Conceptual Understanding, Procedural Fluency, and Application

In order for our students to be mathematically proficient, the standards focus on a balanced development of conceptual understanding, procedural fluency, and application. Through this balance, students gain understanding and critical thinking skills that are necessary to be truly college and career ready.

Conceptual understanding refers to understanding mathematical concepts, operations, and relations. It is more than knowing isolated facts and methods. Students should be able to make sense of why a mathematical idea is important and the kinds of contexts in which it is useful. It also allows students to connect prior knowledge to new ideas and concepts.

Procedural fluency is the ability to apply procedures accurately, efficiently, and flexibly. One cannot stop with memorization of facts and procedures alone. It is about recognizing when one strategy or procedure is more appropriate to apply than another. Students need opportunities to justify both informal strategies and commonly used procedures through distributed practice. Procedural fluency includes computational fluency with the four arithmetic operations. In the early grades, students are expected to develop fluency with whole numbers in addition, subtraction, multiplication, and division. Therefore, computational fluency expectations are addressed throughout the standards. Procedural fluency extends students' computational fluency and applies in all strands of mathematics. It builds from initial exploration and discussion of number concepts to using informal strategies and the properties of operations to develop general methods for solving problems (NCTM, 2014).

Application provides a valuable context for learning and the opportunity to practice skills in a relevant and a meaningful way. As early as Kindergarten, students are solving simple "word problems" with meaningful contexts. In fact, it is in solving word problems that students are building a repertoire of procedures for computation. They learn to select an efficient strategy and determine whether the solution(s) makes sense. Problem solving provides an important context in which students learn about numbers and other mathematical topics by reasoning and developing critical thinking skills (Adding It Up, 2001).

Progressions

The standards for each grade are not written to be nor are they to be considered as an island in and of themselves. There is a flow, or progression, from one grade to the next, all the way through to the high school standards. There are four main progressions that are composed of mathematical domains/conceptual categories (see the Structure section below and color chart on the following page).

The progressions are grouped as follows:

Grade	Domain/Conceptual Category
K	Counting and Cardinality
K-5	Number and Operations in Base Ten
3-5	Number and Operations – Fractions
6-7	Ratios and Proportional Relationships
6-8	The Number System
9-12	Number and Quantity
<hr/>	
K-5	Operations and Algebraic Thinking
6-8	Expressions and Equations
8	Functions
9-12	Algebra and Functions
<hr/>	
K-12	Geometry
<hr/>	
K-5	Measurement and Data
6-12	Statistics and Probability

State Standards – Mathematics

Learning Progressions

Kindergarten	1	2	3	4	5	6	7	8	HS
Counting and Cardinality									Number and Quantity
Number and Operations in Base Ten					Ratios and Proportional Relationships				
			Number and Operations - Fractions		The Number System				
Operations and Algebraic Thinking						Expressions and Equations			Algebra
									Functions
Geometry						Geometry			Geometry
Measurement and Data						Statistics and Probability			Statistics and Probability

Each of the progressions begins in Kindergarten, with a constant movement toward the high school standards as a student advances through the grades. This is very important to guarantee a steady, age appropriate progression which allows the student and teacher alike to see the overall coherence of and connections among the mathematical topics. It also ensures that gaps are not created in the mathematical education of our students.

Structure of the Standards

Most of the structure of the previous state standards has been maintained. This structure is logical and informative as well as easy to follow. An added benefit is that most Tennessee teachers are already familiar with it.

The structure includes:

- **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.

Standards and Curriculum

It should be noted that the standards are what students should know, understand, and be able to do; but, they do not dictate how a teacher is to teach them. In other words, the standards do not dictate curriculum. For example, students are to understand and be able to add, subtract, multiply, and divide fractions according to the standards. Although within the standards algorithms are mentioned and examples are given for clarification, how to approach these concepts and the order in which the standards are taught within a grade or course are all decisions determined by the local district, school, and teachers.

Example from the Standards' Document for K – 8

Taken from 3rd Grade Standards:

Measurement and Data (MD)	
Cluster Headings	Content Standards
A. Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.	<p>3.MD.A.1 Tell and write time to the nearest minute and measure time intervals in minutes. Solve contextual problems involving addition and subtraction of time intervals in minutes. <i>For example, students may use a number line to determine the difference between the start time and the end time of lunch.</i></p> <p>3.MD.A.2 Measure the mass of objects and liquid volume using standard units of grams (g), kilograms (kg), milliliters (ml), and liters (l). Estimate the mass of objects and liquid volume using benchmarks. <i>For example, a large paper clip is about one gram, so a box of about 100 large clips is about 100 grams. Therefore, ten boxes would be about 1 kilogram.</i></p>

The domain is indicated at the top of the table of standards. The left column of the table contains the cluster headings. A light green coloring of the cluster heading (and codes of each of the standards within that cluster) indicates the major work of the grade. Supporting standards have no coloring. In this way, printing on a non-color printer, the standards belonging to the major work of the grade will be lightly shaded and stand distinct from the supporting standards. This color coding scheme will be followed throughout all standards K – 12. Next to the clusters are the content standards that indicate specifically what a student is to know, understand, and do with respect to that cluster. The numbering scheme for K-8 is intuitive and consistent throughout the grades. The numbering scheme for the high school standards will be somewhat different.

Example coding for grades K-8 standards:

3.MD.A.1

3 is the grade level.

Measurement and Data (**MD**) is the domain.

A is the cluster (ordered by A, B, C, etc. for first cluster, second cluster, etc.).

1 is the standard number (the standards are numbered consecutively throughout each domain regardless of cluster).

Example from the Standards' Document for 9 – 12

Taken from Integrated Math 1 Standards:

Algebra		
Seeing Structure in Expressions (A.SSE)		
Cluster Headings	Content Standards	Scope & Clarifications
A. Interpret the structure of expressions.	M1.A.SSE.A.1 Interpret expressions that represent a quantity in terms of its context. *	<p>For example, interpret $P(1 + r)^n$ as the product of P and a factor not depending on P.</p> <p>Tasks are limited to linear and exponential expressions, including related numerical expressions.</p>
	<p>a. Interpret parts of an expression, such as terms, factors, and coefficients.</p> <p>b. Interpret complicated expressions by viewing one or more of their parts as a single entity.</p>	

The high school standards follow a slightly different coding structure. They start with the course indicator (M1 – Integrated Math 1, A1 – Algebra 1, G – Geometry, etc.), then the conceptual category (in the example below – Algebra) and then the domain (just above the table of standards it represents – Seeing Structure in Expressions). There are various domains under each conceptual category. The table of standards contains the cluster headings (see explanation above), content standards, and the scope and clarifications column, which gives further clarification of the standard and the extent of its coverage in the course. A * with a standard indicates a modeling standard (see MP4 on p.11). The color coding is light green for the major work of the grade and no color for the supporting standards.

Example coding for grades 9-12 standards:

M1.A.SSE.A.1

Integrated Math 1 (**M1**) is the course.

Algebra (**A**) is the conceptual category.

Seeing Structure in Expressions (**SSE**) is the domain.

A is the cluster (ordered by A, B, C, etc. for first cluster, second cluster, etc.).

1 is the standard number (the standards are numbered consecutively throughout each domain regardless of cluster).

Tennessee State Math Standards

The Standards for Mathematical Practice

Being successful in mathematics requires that development of approaches, practices, and habits of mind be in place as one strives to develop mathematical fluency, procedural skills, and conceptual understanding. The Standards for Mathematical Practice are meant to address these areas of expertise that teachers should seek to develop within their students. These approaches, practices, and habits of mind can be summarized as “processes and proficiencies” that successful mathematicians have as a part of their work in mathematics.

Processes and proficiencies are two words that address the purpose and intent of the practice standards. Process is used to indicate a particular course of action intended to achieve a result, and this ties to the process standards from NCTM that pertain to problem solving, reasoning and proof, communication, representation, and connections. Proficiencies pertain to being skilled in the command of fundamentals derived from practice and familiarity. Mathematically, this addresses concepts such as adaptive reasoning, strategic competence, conceptual understanding, procedural fluency, and productive dispositions toward the work at hand. The practice standards are written to address the needs of the student with respect to being successful in mathematics.

These standards are most readily developed in the solving of high-level mathematical tasks. High-level tasks demand a greater level of cognitive effort to solve than routine practice problems do. Such tasks require one to make sense of the problem and work at solving it. Often a student must reason abstractly and quantitatively as he or she constructs an approach. The student must be able to argue his or her point as well as critique the reasoning of others with respect to the task. These tasks are rich enough to support various entry points for finding solutions. To develop the processes and proficiencies addressed in the practice standards, students must be engaged in rich, high-level mathematical tasks that support the approaches, practices, and habits of mind which are called for within these standards.

The following are the eight standards for mathematical practice:

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 others.
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.

A full description of each of these standards follows.

MP1: Make sense of problems and persevere in solving them.

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

MP2: Reason abstractly and quantitatively.

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to *decontextualize*—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to *contextualize*, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand, considering the units involved, attending to the meaning of quantities, not just how to compute them, and knowing and flexibly using different properties of operations and objects.

MP3: Construct viable arguments and critique the reasoning of others.

Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and, if there is a flaw in an argument, explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

MP4: Model with mathematics.

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts, and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

MP5: Use appropriate tools strategically.

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a compass, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

MP6: Attend to precision.

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, expressing numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school, they have learned to examine claims and make explicit use of definitions.

MP7: Look for and make use of structure.

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students see 7×8 equals the well-remembered $7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2×7 and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y .

MP8: Look for and express regularity in repeated reasoning.

Mathematically proficient students notice if calculations are repeated and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y - 2)/(x - 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x - 1)(x + 1)$, $(x - 1)(x^2 + x + 1)$, and $(x - 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.

Literacy Skills for Mathematical Proficiency

Communication in mathematics employs literacy skills in reading, vocabulary, speaking and listening, and writing. Mathematically proficient students communicate using precise terminology and multiple representations including graphs, tables, charts, and diagrams. By describing and contextualizing mathematics, students create arguments and support conclusions. They evaluate and critique the reasoning of others and analyze and reflect on their own thought processes. Mathematically proficient students have the capacity to engage fully with mathematics in context by posing questions, choosing appropriate problem-solving approaches, and justifying solutions.

Literacy Skills for Mathematical Proficiency

1. Use multiple reading strategies.
2. Understand and use correct mathematical vocabulary.
3. Discuss and articulate mathematical ideas.
4. Write mathematical arguments.

Reading

Reading in mathematics is different from reading literature. Mathematics contains expository text along with precise definitions, theorems, examples, graphs, tables, charts, diagrams, and exercises. Students are expected to recognize multiple representations of information, use mathematics in context, and draw conclusions from the information presented. In the early grades, non-readers and struggling readers benefit from the use of multiple representations and contexts to develop mathematical connections, processes, and procedures. As students' literacy skills progress, their skills in mathematics develop so that by high school, students are using multiple reading strategies, analyzing context-based problems to develop understanding and comprehension, interpreting and using multiple representations, and fully engaging with mathematics textbooks and other mathematics-based materials. These skills support Mathematical Practices 1 and 2.

Vocabulary

Understanding and using mathematical vocabulary correctly is essential to mathematical proficiency. Mathematically proficient students use precise mathematical vocabulary to express ideas. In all grades, separating mathematical vocabulary from everyday use of words is important for developing an understanding of mathematical concepts. For example, a "table" in everyday use means a piece of furniture, while in mathematics, a "table" is a way of organizing and presenting information. Mathematically proficient students are able to parse a mathematical term, definition, or theorem, provide examples and counterexamples, and use precise mathematical vocabulary in reading, speaking, and writing arguments and explanations. These skills support Mathematical Practice 6.

Speaking and Listening

Mathematically proficient students can listen critically, discuss, and articulate their mathematical ideas clearly to others. As students' mathematical abilities mature, they move from communicating through reiterating others' ideas to paraphrasing, summarizing, and drawing their own conclusions. A

mathematically proficient student uses appropriate mathematics vocabulary in verbal discussions, listens to mathematical arguments, and dissects an argument to recognize flaws or determine validity. These skills support Mathematical Practice 3.

Writing

Mathematically proficient students write mathematical arguments to support and refute conclusions and cite evidence for these conclusions. Throughout all grades, students write reflectively to compare and contrast problem-solving approaches, evaluate mathematical processes, and analyze their thinking and decision-making processes to improve their mathematical strategies. These skills support Mathematical Practices 2, 3, and 4.

Geometry | G

Geometry emphasizes similarity, right triangle trigonometry, congruence, and modeling geometry concepts in real life situations. Students build upon previous knowledge of similarity, congruence, and triangles to prove theorems and reason mathematically. This course also introduces students to geometric constructions and circles. Students show a progression of mastery and understanding of the use and application of surface area and volume.

The major work of Geometry is from the following domains and clusters:

- **Congruence**
 - Understand congruence in terms of rigid motions.
 - Prove geometric theorems.
- **Similarity, Right Triangles, and Trigonometry**
 - Understand similarity in terms of similarity transformations.
 - Prove theorems involving similarity.
 - Define trigonometric ratios and solve problems involving triangles.
- **Expressing Geometric Properties with Equations**
 - Use coordinates to prove simple geometric theorems algebraically.
- **Modeling with Geometry**
 - Apply geometric concepts in modeling situations.

Supporting work is from the following domains and clusters:

- **Congruence**
 - Experiment with transformations in the plane.
 - Make geometric constructions.
- **Circles**
 - Understand and apply theorems about circles.
 - Find areas of sectors of circles.
- **Expressing Geometric Properties with Equations**
 - Translate between the geometric description and the equation for a circle.
- **Geometric Measurement and Dimension**
 - Explain volume and surface area formulas and use them to solve problems.

Mathematical Modeling

Mathematical Modeling is a Standard for Mathematical Practice (MP4) and a Conceptual Category. Specific modeling standards appear throughout the high school standards indicated with a star (★). Where an entire domain is marked with a star, each standard in that domain is a modeling standard.

Standards for Mathematical Practice

Being successful in mathematics requires the development of approaches, practices, and habits of mind that need to be in place as one strives to develop mathematical fluency, procedural skills, and conceptual understanding. The Standards for Mathematical Practice are meant to address these areas of expertise that teachers should seek to develop in their students. These approaches, practices, and habits of mind can be summarized as “processes and proficiencies” that successful mathematicians have as a part of their work in mathematics. Additional explanations are included in the main introduction of these standards.

Standards for Mathematical Practice
<ol style="list-style-type: none">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.8. Look for and express regularity in repeated reasoning.

Literacy Standards for Mathematics

Communication in mathematics employs literacy skills in reading, vocabulary, speaking and listening, and writing. Mathematically proficient students communicate using precise terminology and multiple representations including graphs, tables, charts, and diagrams. By describing and contextualizing mathematics, students create arguments and support conclusions. They evaluate and critique the reasoning of others, analyze, and reflect on their own thought processes. Mathematically proficient students have the capacity to engage fully with mathematics in context by posing questions, choosing appropriate problem-solving approaches, and justifying solutions. Further explanations are included in the main introduction.

Literacy Skills for Mathematical Proficiency
<ol style="list-style-type: none">1. Use multiple reading strategies.2. Understand and use correct mathematical vocabulary.3. Discuss and articulate mathematical ideas.4. Write mathematical arguments.

Geometry

Congruence (G.CO)

Cluster Headings	Content Standards	Scope & Clarifications
A. Experiment with transformations in the plane.	G.CO.A.1 Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, plane, distance along a line, and distance around a circular arc.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
	G.CO.A.2 Represent transformations in the plane in multiple ways, including technology. Describe transformations as functions that take points in the plane (pre-image) as inputs and give other points (image) as outputs. Compare transformations that preserve distance and angle measure to those that do not (e.g., translation versus horizontal stretch).	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
	G.CO.A.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry the shape onto itself.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
	G.CO.A.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
	G.CO.A.5 Given a geometric figure and a rigid motion, draw the image of the figure in multiple ways, including technology. Specify a sequence of rigid motions that will carry a given figure onto another.	<i>Rigid motions include rotations, reflections, and translations.</i> <i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
B. Understand congruence in terms of rigid motions.	G.CO.B.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to determine informally if they are congruent.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>

Cluster Headings

Content Standards

Scope & Clarifications

<p>B. Understand congruence in terms of rigid motions.</p>	<p>G.CO.B.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.</p>	<p><i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i></p>
	<p>G.CO.B.8 Explain how the criteria for triangle congruence (ASA, SAS, AAS, and SSS) follow from the definition of congruence in terms of rigid motions.</p>	<p><i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i></p>
<p>C. Prove geometric theorems.</p>	<p>G.CO.C.9 Prove theorems about lines and angles.</p>	<p><i>Proving includes, but is not limited to, completing partial proofs; constructing two-column or paragraph proofs; using transformations to prove theorems; analyzing proofs; and critiquing completed proofs.</i></p> <p><i>Theorems include but are not limited to: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.</i></p>
	<p>G.CO.C.10 Prove theorems about triangles.</p>	<p><i>Proving includes, but is not limited to, completing partial proofs; constructing two-column or paragraph proofs; using transformations to prove theorems; analyzing proofs; and critiquing completed proofs.</i></p> <p><i>Theorems include but are not limited to: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.</i></p>

Cluster Headings	Content Standards	Scope & Clarifications
C. Prove geometric theorems.	G.CO.C.11 Prove theorems about parallelograms.	<p><i>Proving includes, but is not limited to, completing partial proofs; constructing two-column or paragraph proofs; using transformations to prove theorems; analyzing proofs; and critiquing completed proofs.</i></p> <p><i>Theorems include but are not limited to: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.</i></p>
D. Make geometric constructions.	G.CO.D.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).	<p><i>Constructions include but are not limited to: copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; constructing a line parallel to a given line through a point not on the line, and constructing the following objects inscribed in a circle: an equilateral triangle, square, and a regular hexagon.</i></p>

Similarity, Right Triangles, and Trigonometry (G.SRT)

Cluster Headings	Content Standards	Scope & Clarifications
A. Understand similarity in terms of similarity transformations.	G.SRT.A.1 Verify informally the properties of dilations given by a center and a scale factor.	<p><i>Properties include but are not limited to: a dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center of the dilation unchanged; the dilation of a line segment is longer or shorter in the ratio given by the scale factor.</i></p>

Cluster Headings

Content Standards

Scope & Clarifications

A. Understand similarity in terms of similarity transformations	G.SRT.A.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
	G.SRT.A.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
B. Prove theorems involving similarity.	G.SRT.B.4 Prove theorems about similar triangles.	<i>Proving includes, but is not limited to, completing partial proofs; constructing two-column or paragraph proofs; using transformations to prove theorems; analyzing proofs; and critiquing completed proofs.</i> <i>Theorems include but are not limited to: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.</i>
	G.SRT.B.5 Use congruence and similarity criteria for triangles to solve problems and to justify relationships in geometric figures.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
C. Define trigonometric ratios and solve problems involving triangles.	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.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
	G.SRT.C.7 Explain and use the relationship between the sine and cosine of complementary angles.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>

Cluster Headings	Content Standards	Scope & Clarifications
C. Define trigonometric ratios and solve problems involving triangles.	G.SRT.C.8 Solve triangles. *	<i>Ambiguous cases will not be included in assessment.</i>
	<p>a. Know and use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.</p> <p>b. Know and use the Law of Sines and Law of Cosines to solve problems in real life situations. Recognize when it is appropriate to use each.</p>	

Circles (G.C)

Cluster Headings	Content Standards	Scope & Clarifications
A. Understand and apply theorems about circles.	G.C.A.1 Recognize that all circles are similar.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
	G.C.A.2 Identify and describe relationships among inscribed angles, radii, and chords.	<i>Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle, and properties of angles for a quadrilateral inscribed in a circle.</i>
	G.C.A.3 Construct the incenter and circumcenter of a triangle and use their properties to solve problems in context.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
B. Find areas of sectors of circles.	G.C.B.4 Know the formula and find the area of a sector of a circle in a real-world context.	<p><i>For example, use proportional relationships and angles measured in degrees or radians.</i></p> <p><i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i></p>

Expressing Geometric Properties with Equations (G.GPE)

Cluster Headings	Content Standards	Scope & Clarifications
A. Translate between the geometric description and the equation for a circle.	G.GPE.A.1 Know and write the equation of a circle of given center and radius using the Pythagorean Theorem.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
B. Use coordinates to prove simple geometric theorems algebraically.	G.GPE.B.2 Use coordinates to prove simple geometric theorems algebraically.	<p><i>For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{5})$ lies on the circle centered at the origin and containing the point $(0, 2)$.</i></p> <p><i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i></p>
	G.GPE.B.3 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems.	<p><i>For example, find the equation of a line parallel or perpendicular to a given line that passes through a given point.</i></p> <p><i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i></p>
	G.GPE.B.4 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.	<i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i>
	G.GPE.B.5 Know and use coordinates to compute perimeters of polygons and areas of triangles and rectangles.*	<p><i>For example, use the distance formula.</i></p> <p><i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i></p>

Geometric Measurement and Dimension (G.GMD)

Cluster Headings	Content Standards	Scope & Clarifications
A. Explain volume and surface area formulas and use them to solve problems.	G.GMD.A.1 Give an informal argument for the formulas for the circumference of a circle and the volume and surface area of a cylinder, cone, prism, and pyramid.	<p><i>Informal arguments may include but are not limited to using the dissection argument, applying Cavalieri's principle, and constructing informal limit arguments.</i></p> <p><i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i></p>
	G.GMD.A.2 Know and use volume and surface area formulas for cylinders, cones, prisms, pyramids, and spheres to solve problems.*	<p><i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i></p>

Modeling with Geometry (G.MG)

Cluster Headings	Content Standards	Scope & Clarifications
A. Apply geometric concepts in modeling situations.	G.MG.A.1 Use geometric shapes, their measures, and their properties to describe objects.*	<p><i>For example, model a tree trunk or a human torso as a cylinder.</i></p> <p><i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i></p>
	G.MG.A.2 Apply geometric methods to solve real-world problems.*	<p><i>Geometric methods may include but are not limited to using geometric shapes, the probability of a shaded region, density, and design problems.</i></p> <p><i>There are no assessment limits for this standard. The entire standard is assessed in this course.</i></p>

Major content of the course is indicated by the light green shading of the cluster heading and standard's coding.

	Major Content		Supporting Content
--	----------------------	--	---------------------------