Georgia Tutorials are designed specifically for the Georgia Standards of Excellence and the Georgia Performance Standards to prepare students for the Georgia Milestones.

Math Tutorials offer targeted instruction, practice and review designed to develop computational fluency, deepen conceptual understanding, and apply mathematical practices. They automatically identify and address learning gaps down to elementary-level content, using adaptive remediation to bring students to grade-level no matter where they start. Students engage with the content in an interactive, feedback-rich environment as they progress through standards-aligned modules. By constantly honing the ability to apply their knowledge in abstract and real world scenarios, students build the depth of knowledge and higher order skills required to demonstrate their mastery when put to the test.

In each module, the Learn It and Try It make complex ideas accessible to students through focused content, modeled logic and process, multi-modal representations, and personalized feedback as students reason through increasingly challenging problems. The Review It offers a high impact summary of key concepts and relates those concepts to students' lives. The Test It assesses students' mastery of the module's concepts, providing granular performance data to students and teachers after each attempt. To help students focus on the content most relevant to them, unit-level pretests and posttests can quickly identify where students are strong and where they're still learning.

1. REAL NUMBER SYSTEM

- **LAWS OF EXPONENTS**
  - **MGSE9-12.A.SSE.2** *Use the structure of an expression to rewrite it in different equivalent forms.*
  - **MGSE9-12.N.RN.2** *Rewrite expressions involving radicals (i.e., simplify and/or use the operations of addition, subtraction, and multiplication, with radicals within expressions limited to square roots).*

- **OPERATIONS ON RATIONAL AND IRRATIONAL NUMBERS**
  - **MGSE9-12.N.RN.3** *Explain why the sum or product of rational numbers is rational; why the sum of a rational number and an irrational number is irrational; and why the product of a nonzero rational number and an irrational number is irrational.*

2. EXPRESSIONS AND EQUATIONS

- **FORMULATING AND SIMPLIFYING ALGEBRAIC EXPRESSIONS**
  - **MGSE9-12.F.BF.1a** *Determine an explicit expression and the recursive process (steps for calculation) from context.*
  - **MGSE9-12.A.SSE.1a** *Interpret parts of an expression, such as terms, factors, and coefficients, in context.*
  - **MGSE9-12.A.SSE.1b** *Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.*
  - **MGSE9-12.A.SSE.2** *Use the structure of an expression to rewrite it in different equivalent forms.*

- **LITERAL EQUATIONS**
  - **MGSE9-12.A.CED.1** *Create equations and inequalities in one variable and use them to solve problems. Include equations arising from quadratic functions.*
  - **MGSE9-12.A.CED.4** *Rearrange formulas to highlight a quantity of interest using the same reasoning as in solving equations.*

3. FUNCTIONS

- **FUNCTIONS AND RELATIONS**
  - **MGSE9-12.F.IF.4** *Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior.*

- **DOMAIN AND RANGE**
  - **MGSE9-12.F.IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*

4. SEQUENCES

- **SEQUENCES**
  - **MGSE9-12.F.BF.1a** *Determine an explicit expression and the recursive process (steps for calculation) from context.*

- **ARITHMETIC AND GEOMETRIC SEQUENCES**
  - **MGSE9-12.F.BF.1a** *Determine an explicit expression and the recursive process (steps for calculation) from context.*

5. OPERATIONS ON POLYNOMIALS

- **ADDITION AND SUBTRACTION OF POLYNOMIALS**
  - **MGSE9-12.A.APR.1** *Add, subtract, and multiply polynomials; understand that polynomials form a system analogous to the integers in that they are closed under these operations.*

- **MULTIPLICATION OF POLYNOMIALS**
  - **MGSE9-12.A.APR.1** *Add, subtract, and multiply polynomials; understand that polynomials form a system analogous to the integers in that they are closed under these operations.*

6. FACTORING

- **FACTORING QUADRATIC TRINOMIALS**
  - **MGSE9-12.A.SSE.3a** *Factor any quadratic expression to reveal the zeros of the function defined by the expression.*
  - **MGSE9-12.A.SSE.2** *Use the structure of an expression to rewrite it in different equivalent forms.*
  - **MGSE9-12.A.SSE.1a** *Interpret parts of an expression, such as terms, factors, and coefficients, in context.*
  - **MGSE9-12.A.SSE.1b** *Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.*
  - **MGSE9-12.A.REI.4b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).*

- **FACTORING SPECIAL CASES**
  - **MGSE9-12.A.SSE.1a** *Interpret parts of an expression, such as terms, factors, and coefficients, in context.*
  - **MGSE9-12.A.SSE.1b** *Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.*
  - **MGSE9-12.A.SSE.2** *Use the structure of an expression to rewrite it in different equivalent forms.*

7. GRAPHS OF QUADRATIC FUNCTIONS

- **QUADRATIC FUNCTIONS**
  - **MGSE9-12.F.IF.4** *Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior.*
  - **MGSE9-12.A.CED.2** *Create quadratic equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (The phrase "in two or more variables" refers to formulas like the compound interest formula, in which $A = P(1 + r/n)nt$ has multiple variables.)*
  - **MGSE9-12.A.SSE.1a** *Interpret parts of an expression, such as terms, factors, and coefficients, in context.*
  - **MGSE9-12.A.SSE.1b** *Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.*

- **MGSE9-12.A.SSE.3b** *Complete the square in a quadratic expression to reveal the maximum or minimum value of the function defined by the expression.*
- **MGSE9-12.F.IF.8a** *Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.*
- **MGSE9-12.F.BF.1a** *Determine an explicit expression and the recursive process (steps for calculation) from context.*

- **ANALYZING GRAPHS OF QUADRATIC FUNCTIONS**
  - **MGSE9-12.A.SSE.2** *Use the structure of an expression to rewrite it in different equivalent forms.*
  - **MGSE9-12.F.IF.9** *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).*
  - **MGSE9-12.F.IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
  - **MGSE9-12.F.IF.4** *Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior.*
  - **MGSE9-12.A.REI.4b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).*
  - **MGSE9-12.F.IF.8a** *Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.*
  - **MGSE9-12.F.IF.7a** *Graph quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context).*

- **REPRESENTATIONS OF QUADRATIC FUNCTIONS**
  - **MGSE9-12.A.SSE.2** *Use the structure of an expression to rewrite it in different equivalent forms.*
  - **MGSE9-12.A.REI.4a** *Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from $ax^2 + bx + c = 0$.*
  - **MGSE9-12.A.CED.2** *Create quadratic equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (The phrase "in two or more variables" refers to formulas like the compound interest formula, in which $A = P(1 + r/n)nt$ has multiple variables.)*
  - **MGSE9-12.F.IF.4** *Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior.*
  - **MGSE9-12.F.IF.8a** *Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.*
  - **MGSE9-12.F.IF.9** *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).*
  - **MGSE9-12.F.BF.1a** *Determine an explicit expression and the recursive process (steps for calculation) from context.*

8. SOLVING QUADRATIC FUNCTIONS

- **SOLVING QUADRATIC EQUATIONS BY FACTORING**
  - **MGSE9-12.A.SSE.3a** *Factor any quadratic expression to reveal the zeros of the function defined by the expression.*
  - **MGSE9-12.A.REI.4b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).*
  - **MGSE9-12.F.IF.8a** *Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.*
  - **MGSE9-12.F.IF.7a** *Graph quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context).*
  - **MGSE9-12.F.IF.4** *Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior.*
  - **MGSE9-12.F.BF.1a** *Determine an explicit expression and the recursive process (steps for calculation) from context.*

- **COMPLETING THE SQUARE**
  - **MGSE9-12.A.SSE.3b** *Complete the square in a quadratic expression to reveal the maximum or minimum value of the*

function defined by the expression.

- **MGSE9-12.A.REI.4a** *Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from $ax^2 + bx + c = 0$.*
- **MGSE9-12.A.REI.4b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).*
- **MGSE9-12.F.IF.8a** *Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.*
- **MGSE9-12.A.SSE.2** *Use the structure of an expression to rewrite it in different equivalent forms.*
- **MGSE9-12.F.IF.4** *Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior.*
- **MGSE9-12.F.IF.7a** *Graph quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context).*

- **QUADRATIC FORMULA**
  - **MGSE9-12.A.SSE.1a** *Interpret parts of an expression, such as terms, factors, and coefficients, in context.*
  - **MGSE9-12.A.SSE.1b** *Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.*
  - **MGSE9-12.A.REI.4b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).*
  - **MGSE9-12.F.IF.4** *Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior.*
  - **MGSE9-12.A.REI.4a** *Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from $ax^2 + bx + c = 0$.*
  - **MGSE9-12.F.BF.1a** *Determine an explicit expression and the recursive process (steps for calculation) from context.*

9. TRANSFORMATIONS ON PARENT FUNCTIONS

- **QUADRATIC PARENT FUNCTION**
  - **MGSE9-12.F.IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
  - **MGSE9-12.F.BF.3** *Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.*

- **TRANSFORMATIONS OF THE QUADRATIC PARENT FUNCTION**
  - **MGSE9-12.F.BF.3** *Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.*
  - **MGSE9-12.F.IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*

10. WORKING WITH FUNCTIONS

- **LINEAR VERSUS NONLINEAR FUNCTIONS**
  - **MGSE9-12.F.IF.4** *Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior.*
  - **MGSE9-12.F.IF.6** *Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*
  - **MGSE9-12.F.LE.3** *Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*
  - **MGSE9-12.F.IF.9** *Compare properties of two functions each represented in a different way (algebraically, graphically,*

numerically in tables, or by verbal descriptions).

- **MGSE9-12.F.BF.3** *Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.*

- **MULTIPLE REPRESENTATIONS OF FUNCTIONS**
  - **MGSE9-12.A.CED.2** *Create quadratic equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (The phrase "in two or more variables" refers to formulas like the compound interest formula, in which A = P(1 + r/n)nt has multiple variables.)*
  - **MGSE9-12.F.IF.9** *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).*

11. POINTS, LINES, AND ANGLES

- **PARALLEL LINES AND ANGLE RELATIONSHIPS**
  - **MGSE9-12.G.CO.9** *Prove theorems about lines and angles.*

- **PERPENDICULAR BISECTOR AND ANGLE BISECTOR THEOREMS**
  - **MGSE9-12.G.CO.9** *Prove theorems about lines and angles.*
  - **MGSE9-12.G.CO.10** *Prove theorems about triangles.*

12. COORDINATE GEOMETRY

- **CONJECTURES IN COORDINATE GEOMETRY**
  - **MGSE9-12.G.CO.10** *Prove theorems about triangles.*
  - **MGSE9-12.G.GPE.4** *Use coordinates to prove simple geometric theorems algebraically.*

- **TRANSFORMATIONS ON THE COORDINATE PLANE**
  - **MGSE9-12.G.CO.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 decide if they are congruent.*
  - **MGSE9-12.G.SRT.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.*
  - **MGSE9-12.G.SRT.1a** *The dilation of a line not passing through the center of the dilation results in a parallel line and leaves a line passing through the center unchanged.*
  - **MGSE9-12.G.SRT.1b** *The dilation of a line segment is longer or shorter according to the ratio given by the scale factor.*

- **DILATIONS, TRANSLATIONS, ROTATIONS, AND REFLECTIONS**
  - **MGSE9-12.G.CO.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 decide if they are congruent.*
  - **MGSE9-12.G.SRT.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.*
  - **MGSE9-12.G.SRT.1a** *The dilation of a line not passing through the center of the dilation results in a parallel line and leaves a line passing through the center unchanged.*
  - **MGSE9-12.G.SRT.1b** *The dilation of a line segment is longer or shorter according to the ratio given by the scale factor.*

13. TRIANGLES AND TRANSFORMATIONS

- **TRIANGLES AND CONGRUENCE TRANSFORMATIONS**

- **MGSE9-12.G.CO.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 decide if they are congruent.*
- **MGSE9-12.G.CO.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.*
- **MGSE9-12.G.CO.8** *Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions. (Extend to include HL and AAS.)*
- **MGSE9-12.G.CO.10** *Prove theorems about triangles.*
- **MGSE9-12.G.SRT.5** *Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.*

TRIANGLES AND SIMILARITY TRANSFORMATIONS

- **MGSE9-12.G.CO.10** *Prove theorems about triangles.*
- **MGSE9-12.G.SRT.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.*
- **MGSE9-12.G.SRT.4** *Prove theorems about triangles.*
- **MGSE9-12.G.SRT.5** *Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.*
- **MGSE9-12.G.SRT.3** *Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.*

14. CONGRUENCE AND SIMILARITY OF OTHER POLYGONS

CONGRUENCE OF OTHER POLYGONS

- **MGSE9-12.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).*
- **MGSE9-12.G.CO.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 decide if they are congruent.*

SIMILARITY OF OTHER POLYGONS

- **MGSE9-12.G.SRT.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.*

15. TRIANGLES

TRIANGLE ANGLE THEOREMS

- **MGSE9-12.G.CO.10** *Prove theorems about triangles.*

TRIANGLE BISECTORS

- **MGSE9-12.G.CO.9** *Prove theorems about lines and angles.*
- **MGSE9-12.G.CO.10** *Prove theorems about triangles.*
- **MGSE9-12.G.SRT.5** *Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.*
- **MGSE9-12.G.SRT.4** *Prove theorems about triangles.*
- **MGSE9-12.G.CO.12** *Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.*
- **MGSE9-12.G.C.3** *Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.*

MEDIANS AND ALTITUDES OF TRIANGLES

- MEDIANS AND ALTITUDES OF TRIANGLES
  - **MGSE9-12.G.CO.10** *Prove theorems about triangles.*

16. QUADRILATERALS AND CONSTRUCTIONS

- **PARALLELOGRAMS AND RECTANGLES**
  - **MGSE9-12.G.CO.11** *Prove theorems about parallelograms.*
  - **MGSE9-12.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).*

- **SQUARES AND RHOMBI**
  - **MGSE9-12.G.CO.11** *Prove theorems about parallelograms.*
  - **MGSE9-12.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).*

- **CONSTRUCTIONS**
  - **MGSE9-12.G.CO.12** *Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.*
  - **MGSE9-12.G.CO.13** *Construct an equilateral triangle, a square, and a regular hexagon, each inscribed in a circle.*
  - **MGSE9-12.G.C.4** *Construct a tangent line from a point outside a given circle to the circle.*

17. RIGHT TRIANGLES

- **PYTHAGOREAN THEOREM**
  - **MGSE9-12.G.SRT.8** *Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*
  - **MGSE9-12.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).*
  - **MGSE9-12.G.SRT.4** *Prove theorems about triangles.*
  - **MGSE9-12.G.SRT.5** *Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.*
  - **MGSE9-12.G.CO.10** *Prove theorems about triangles.*

- **TRIGONOMETRIC RATIOS**
  - **MGSE9-12.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.*
  - **MGSE9-12.G.SRT.8** *Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*
  - **MGSE9-12.G.SRT.7** *Explain and use the relationship between the sine and cosine of complementary angles.*
  - **MGSE9-12.G.SRT.5** *Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.*
  - **MGSE9-12.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).*

18. TRIANGLES AND TRIGONOMETRY

- **LAWS OF SINE AND COSINE**
  - **MGSE9-12.G.SRT.8** *Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*
  - **MGSE9-12.G.SRT.7** *Explain and use the relationship between the sine and cosine of complementary angles.*

- **RADIANS AND THE UNIT CIRCLE**
  - **MGSE9-12.G.C.5** *Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a*

sector.

- **MGSE9-12.G.SRT.8** *Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

19. CIRCLES AND CONGRUENT CIRCLES

- **CIRCLE BASICS**
  - **MGSE9-12.G.C.2** *Identify and describe relationships among inscribed angles, radii, chords, tangents, and secants. 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.*

- **CONGRUENT AND SIMILAR CIRCLES**
  - **MGSE9-12.G.C.1** *Understand that all circles are similar.*
  - **MGSE9-12.G.CO.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 decide if they are congruent.*
  - **MGSE9-12.G.SRT.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.*

20. CIRCLES AND ANGLES

- **CENTRAL ANGLES, INSCRIBED ANGLES, AND CHORDS**
  - **MGSE9-12.G.C.2** *Identify and describe relationships among inscribed angles, radii, chords, tangents, and secants. 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.*
  - **MGSE9-12.G.CO.9** *Prove theorems about lines and angles.*
  - **MGSE9-12.G.C.3** *Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.*
  - **MGSE9-12.G.C.5** *Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.*

- **SECANTS, ANGLES, AND INTERCEPTED ARCS**
  - **MGSE9-12.G.CO.9** *Prove theorems about lines and angles.*
  - **MGSE9-12.G.C.2** *Identify and describe relationships among inscribed angles, radii, chords, tangents, and secants. 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.*

- **TANGENTS, ANGLES, AND INTERCEPTED ARCS**
  - **MGSE9-12.G.CO.9** *Prove theorems about lines and angles.*
  - **MGSE9-12.G.C.2** *Identify and describe relationships among inscribed angles, radii, chords, tangents, and secants. 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.*

21. MEASURING CIRCLES

- **CIRCUMFERENCE AND ARC LENGTH**
  - **MGSE9-12.G.GMD.1a** *Give informal arguments for the formulas of the circumference of a circle and area of a circle using dissection arguments and informal limit arguments.*
  - **MGSE9-12.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).*

- **AREA OF CIRCLES AND SECTORS**
  - **MGSE9-12.G.GMD.1a** *Give informal arguments for the formulas of the circumference of a circle and area of a circle using*

dissection arguments and informal limit arguments.

- **MGSE9-12.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).*
- **MGSE9-12.G.C.5** *Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.*

- **CIRCLES**
  - **MGSE9-12.G.GPE.1** *Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.*

22. SURFACE AREA

- **SURFACE AREA AND VOLUME OF SPHERES**
  - **MGSE9-12.G.GMD.2** *Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.*
  - **MGSE9-12.G.GMD.3** *Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*
  - **MGSE9-12.G.GMD.4** *Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.*
  - **MGSE9-12.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).*

- **SURFACE AREA OF COMPOSITE SOLIDS**
  - **MGSE9-12.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).*

- **SURFACE AREA OF SIMILAR SOLIDS**
  - **MGSE9-12.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).*

23. VOLUME 1

- **RELATING TWO-DIMENSIONAL FIGURES TO THREE-DIMENSIONAL SOLIDS**
  - **MGSE9-12.G.GMD.4** *Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.*

- **VOLUME OF PRISMS AND PYRAMIDS**
  - **MGSE9-12.G.GMD.2** *Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.*
  - **MGSE9-12.G.GMD.3** *Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*
  - **MGSE9-12.G.GMD.1b** *Give informal arguments for the formula of the volume of a cylinder, pyramid, and cone using Cavalieri's principle.*
  - **MGSE9-12.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).*
  - **MGSE9-12.G.GMD.4** *Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.*

24. VOLUME 2

- **VOLUME OF CYLINDERS AND CONES**
  - **MGSE9-12.G.GMD.2** *Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.*
  - **MGSE9-12.G.GMD.3** *Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*

- **MGSE9-12.G.GMD.1b** *Give informal arguments for the formula of the volume of a cylinder, pyramid, and cone using Cavalieri's principle.*
- **MGSE9-12.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).*
- **MGSE9-12.G.GMD.4** *Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.*

- **MODELING SITUATIONS WITH GEOMETRY**
  - **MGSE9-12.G.MG.2** *Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*
  - **MGSE9-12.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).*

25. VOLUME OF SIMILAR AND COMPOSITE SHAPES

- **VOLUME OF COMPOSITE SOLIDS**
  - **MGSE9-12.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).*
  - **MGSE9-12.G.GMD.3** *Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*
  - **MGSE9-12.G.GMD.2** *Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.*

- **VOLUME OF SIMILAR SOLIDS**
  - **MGSE9-12.G.GMD.3** *Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*
  - **MGSE9-12.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).*

26. STATISTICS AND PROBABILITY

- **SCATTERPLOTS AND MODELING**
  - **MGSE9-12.S.ID.6a** *Decide which type of function is most appropriate by observing graphed data, charted data, or by analysis of context to generate a viable (rough) function of best fit. Use this function to solve problems in context. Emphasize quadratic models.*

- **INTRODUCTION TO PROBABILITY**
  - **MGSE9-12.S.CP.2** *Understand that if two events A and B are independent, the probability of A and B occurring together is the product of their probabilities, and that if the probability of two events A and B occurring together is the product of their probabilities, the two events are independent.*
  - **MGSE9-12.S.CP.5** *Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.*
  - **MGSE9-12.S.CP.1** *Describe categories of events as subsets of a sample space using unions, intersections, or complements of other events (or, and, not).*
  - **MGSE9-12.S.CP.7** *Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answers in context.*

- **CONDITIONAL PROBABILITY**
  - **MGSE9-12.S.CP.3** *Understand the conditional probability of A given B as P (A and B)/P(B). Interpret independence of A and B in terms of conditional probability; that is, the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.*
  - **MGSE9-12.S.CP.5** *Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.*
  - **MGSE9-12.S.CP.6** *Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in context.*
  - **MGSE9-12.S.CP.2** *Understand that if two events A and B are independent, the probability of A and B occurring together is the product of their probabilities, and that if the probability of two events A and B occurring together is the product of their*

probabilities, the two events are independent.

- **MGSE9-12.S.CP.4** *Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities.*

- **GEOMETRIC PROBABILITIES**
  - **MGSE9-12.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).*
  - **MGSE9-12.S.CP.1** *Describe categories of events as subsets of a sample space using unions, intersections, or complements of other events (or, and, not).*
  - **MGSE9-12.S.CP.7** *Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answers in context.*