Massachusetts Tutorials are designed specifically for the Learning Standards found in the Massachusetts Curriculum Frameworks to prepare students for the MCAS tests.

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.

Unit 1: Introductory Geometric Concepts

- **MONITORING PRECISION AND ACCURACY**
  - GEO.N-Q.A.3.a: Number and Quantity Quantities Reason quantitatively and use units to solve problems. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. Describe the effects of approximate error in measurement and rounding on measurements and on computed values from measurements. Identify significant figures in recorded measures and computed values based on the context given and the precision of the tools used to measure.
- **POINTS, RAYS, LINE SEGMENTS, LINES, AND FIGURES**
  - GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
  - GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
- **PARALLEL AND PERPENDICULAR LINES**

- GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
- GEO.G-GPE.B.5: Geometry Expressing Geometric Properties with Equations Use coordinates to prove simple geometric theorems algebraically. Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

Unit 2: Lines and Angles

- **PARALLEL LINES AND ANGLE RELATIONSHIPS**
  - GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
  - GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
  - GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
  - GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
- **PERPENDICULAR BISECTOR AND ANGLE BISECTOR THEOREMS**
  - GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
  - GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely

prove a triangle is isosceles; 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.

- GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-CO.C.11.a: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals. Prove theorems about polygons. Theorems include the measures of interior and exterior angles. Apply properties of polygons to the solutions of mathematical and contextual problems.
- GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
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- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.

Unit 3: Coordinate Geometry I

- **SLOPE-INTERCEPT FORM OF A LINEAR EQUATION**

- GEO.G-GPE.B.5: Geometry Expressing Geometric Properties with Equations Use coordinates to prove simple geometric theorems algebraically. Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

- **LENGTH AND THE DISTANCE FORMULA**
  - GEO.G-GPE.B.6: Geometry Expressing Geometric Properties with Equations Use coordinates to prove simple geometric theorems algebraically. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
  - GEO.G-GPE.B.7: Geometry Expressing Geometric Properties with Equations Use coordinates to prove simple geometric theorems algebraically. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles (e.g., using the distance formula).
  - GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

Unit 4: Coordinate Geometry II

- **MIDPOINT FORMULA ON THE COORDINATE PLANE**
  - GEO.G-GPE.B.6: Geometry Expressing Geometric Properties with Equations Use coordinates to prove simple geometric theorems algebraically. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
  - GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
  - GEO.G-GPE.B.7: Geometry Expressing Geometric Properties with Equations Use coordinates to prove simple geometric theorems algebraically. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles (e.g., using the distance formula).
- **CONJECTURES IN COORDINATE GEOMETRY**
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
  - GEO.G-GPE.B.4: Geometry Expressing Geometric Properties with Equations Use coordinates to prove simple geometric theorems algebraically. Use coordinates to prove simple geometric theorems algebraically, including the distance formula and its relationship to the Pythagorean Theorem.

Unit 5: Perimeter and Area

- **PERIMETER ON THE COORDINATE PLANE**
  - GEO.G-CO.C.11.a: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about parallelograms. Theorems include: opposite sides are

congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals. Prove theorems about polygons. Theorems include the measures of interior and exterior angles. Apply properties of polygons to the solutions of mathematical and contextual problems.

- GEO.G-GPE.B.7: Geometry Expressing Geometric Properties with Equations Use coordinates to prove simple geometric theorems algebraically. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles (e.g., using the distance formula).
- GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
- GEO.G-GPE.B.4: Geometry Expressing Geometric Properties with Equations Use coordinates to prove simple geometric theorems algebraically. Use coordinates to prove simple geometric theorems algebraically, including the distance formula and its relationship to the Pythagorean Theorem.

- **AREA ON THE COORDINATE PLANE**
  - GEO.G-GPE.B.7: Geometry Expressing Geometric Properties with Equations Use coordinates to prove simple geometric theorems algebraically. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles (e.g., using the distance formula).
  - GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

Unit 6: Transformations

- **TRANSFORMATIONS ON THE COORDINATE PLANE**
  - GEO.G-CO.A.2: Geometry Congruence Experiment with transformations in the plane. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).
  - GEO.G-CO.A.5: Geometry Congruence Experiment with transformations in the plane. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
  - GEO.G-CO.B.6: Geometry Congruence Understand congruence in terms of rigid motions. 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.
  - GEO.G-CO.A.3: Geometry Congruence Experiment with transformations in the plane. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

- GEO.G-CO.A.4: Geometry Congruence Experiment with transformations in the plane. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
- GEO.G-CO.C.11.a: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals. Prove theorems about polygons. Theorems include the measures of interior and exterior angles. Apply properties of polygons to the solutions of mathematical and contextual problems.
- GEO.G-SRT.A.2: Geometry Similarity, Right Triangles, and Trigonometry Understand similarity in terms of similarity transformations. 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.
- GEO.G-SRT.A.1.a: Geometry Similarity, Right Triangles, and Trigonometry Understand similarity in terms of similarity transformations. Verify experimentally the properties of dilations given by a center and a scale factor: 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 unchanged.

- **DILATIONS, TRANSLATIONS, ROTATIONS, AND REFLECTIONS**
  - GEO.G-CO.A.5: Geometry Congruence Experiment with transformations in the plane. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
  - GEO.G-CO.B.6: Geometry Congruence Understand congruence in terms of rigid motions. 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.
  - GEO.G-CO.C.11.a: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals. Prove theorems about polygons. Theorems include the measures of interior and exterior angles. Apply properties of polygons to the solutions of mathematical and contextual problems.
  - GEO.G-SRT.A.2: Geometry Similarity, Right Triangles, and Trigonometry Understand similarity in terms of similarity transformations. 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.
  - GEO.G-SRT.A.1.a: Geometry Similarity, Right Triangles, and Trigonometry Understand similarity in terms of similarity transformations. Verify experimentally the properties of dilations given by a center

and a scale factor: 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 unchanged.

- GEO.G-CO.A.2: Geometry Congruence Experiment with transformations in the plane. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).
- GEO.G-CO.A.3: Geometry Congruence Experiment with transformations in the plane. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.
- GEO.G-CO.A.4: Geometry Congruence Experiment with transformations in the plane. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

Unit 7: Congruence

- **TRIANGLES AND CONGRUENCE TRANSFORMATIONS**
  - GEO.G-CO.B.6: Geometry Congruence Understand congruence in terms of rigid motions. 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.
  - GEO.G-CO.B.7: Geometry Congruence Understand congruence in terms of rigid motions. 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.
  - GEO.G-CO.B.8: Geometry Congruence Understand congruence in terms of rigid motions. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
  - GEO.G-SRT.B.5: Geometry Similarity, Right Triangles, and Trigonometry Prove theorems involving similarity. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.

- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.

- **CONGRUENCE OF OTHER POLYGONS**
  - GEO.G-CO.C.11.a: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals. Prove theorems about polygons. Theorems include the measures of interior and exterior angles. Apply properties of polygons to the solutions of mathematical and contextual problems.
  - GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
  - GEO.G-CO.A.5: Geometry Congruence Experiment with transformations in the plane. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
  - GEO.G-CO.B.6: Geometry Congruence Understand congruence in terms of rigid motions. 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.
  - GEO.G-CO.A.2: Geometry Congruence Experiment with transformations in the plane. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).
  - GEO.G-CO.A.3: Geometry Congruence Experiment with transformations in the plane. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

Unit 8: Similarity

- **TRIANGLES AND SIMILARITY TRANSFORMATIONS**

- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-SRT.A.2: Geometry Similarity, Right Triangles, and Trigonometry Understand similarity in terms of similarity transformations. 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.
- GEO.G-SRT.A.3: Geometry Similarity, Right Triangles, and Trigonometry Understand similarity in terms of similarity transformations. Use the properties of similarity transformations to establish the Angle-Angle (AA) criterion for two triangles to be similar.
- GEO.G-SRT.B.4: Geometry Similarity, Right Triangles, and Trigonometry Prove theorems involving similarity. Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.
- GEO.G-SRT.B.5: Geometry Similarity, Right Triangles, and Trigonometry Prove theorems involving similarity. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.

- **SIMILARITY OF OTHER POLYGONS**
  - GEO.G-CO.C.11.a: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals. Prove theorems about polygons.

Theorems include the measures of interior and exterior angles. Apply properties of polygons to the solutions of mathematical and contextual problems.

- GEO.G-SRT.A.2: Geometry Similarity, Right Triangles, and Trigonometry Understand similarity in terms of similarity transformations. 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.

Unit 9: Triangles

- **TRIANGLE ANGLE THEOREMS**
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
  - GEO.G-CO.C.11.a: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals. Prove theorems about polygons. Theorems include the measures of interior and exterior angles. Apply properties of polygons to the solutions of mathematical and contextual problems.
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.

- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-C.A.3: Geometry Circles Understand and apply theorems about circles. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral and other polygons inscribed in a circle.

- **TRIANGLE BISECTORS**
  - GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
  - GEO.G-CO.C.11.a: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals. Prove theorems about polygons. Theorems include the measures of interior and exterior angles. Apply properties of polygons to the solutions of mathematical and contextual problems.
  - GEO.G-SRT.B.4: Geometry Similarity, Right Triangles, and Trigonometry Prove theorems involving similarity. Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.
  - GEO.G-SRT.B.5: Geometry Similarity, Right Triangles, and Trigonometry Prove theorems involving similarity. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
  - GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely

prove a triangle is isosceles; 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.

- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-CO.D.12: Geometry Congruence Make geometric constructions. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Constructions include: 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.
- GEO.G-C.A.3: Geometry Circles Understand and apply theorems about circles. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral and other polygons inscribed in a circle.

- **MEDIANS AND ALTITUDES OF TRIANGLES**
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
  - GEO.G-CO.C.11.a: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and

conversely, rectangles are parallelograms with congruent diagonals. Prove theorems about polygons. Theorems include the measures of interior and exterior angles. Apply properties of polygons to the solutions of mathematical and contextual problems.

- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.

Unit 10: Right Triangles and Trigonometric Ratios

- **PYTHAGOREAN THEOREM**
  - GEO.G-SRT.C.8: Geometry Similarity, Right Triangles, and Trigonometry Define trigonometric ratios and solve problems involving right triangles. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.
  - GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
  - GEO.G-SRT.B.4: Geometry Similarity, Right Triangles, and Trigonometry Prove theorems involving similarity. Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.
  - GEO.G-SRT.B.5: Geometry Similarity, Right Triangles, and Trigonometry Prove theorems involving similarity. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
  - GEO.G-CO.C.10: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.
- **TRIGONOMETRIC RATIOS**

- GEO.G-SRT.C.6: Geometry Similarity, Right Triangles, and Trigonometry Define trigonometric ratios and solve problems involving right triangles. 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.
- GEO.G-SRT.C.8: Geometry Similarity, Right Triangles, and Trigonometry Define trigonometric ratios and solve problems involving right triangles. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.
- GEO.G-SRT.C.7: Geometry Similarity, Right Triangles, and Trigonometry Define trigonometric ratios and solve problems involving right triangles. Explain and use the relationship between the sine and cosine of complementary angles.
- GEO.G-SRT.B.5: Geometry Similarity, Right Triangles, and Trigonometry Prove theorems involving similarity. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
- GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

Unit 11: Trigonometry and Constructions

- **LAWS OF SINE AND COSINE**
  - GEO.G-SRT.C.8: Geometry Similarity, Right Triangles, and Trigonometry Define trigonometric ratios and solve problems involving right triangles. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.
  - GEO.G-SRT.D.9: Geometry Similarity, Right Triangles, and Trigonometry Apply trigonometry to general triangles. Derive the formula = 1/2 ab sin() for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.
  - GEO.G-SRT.D.10: Geometry Similarity, Right Triangles, and Trigonometry Apply trigonometry to general triangles. Prove the Laws of Sines and Cosines and use them to solve problems.
  - GEO.G-SRT.D.11: Geometry Similarity, Right Triangles, and Trigonometry Apply trigonometry to general triangles. Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).
- **RADIANS AND THE UNIT CIRCLE**
  - GEO.G-C.B.5: Geometry Circles Find arc lengths and areas of sectors of circles. 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.
  - GEO.G-SRT.C.8: Geometry Similarity, Right Triangles, and Trigonometry Define trigonometric ratios and solve problems involving right triangles. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.
- **CONSTRUCTIONS**

- GEO.G-CO.D.12: Geometry Congruence Make geometric constructions. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Constructions include: 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.
- GEO.G-CO.D.13: Geometry Congruence Make geometric constructions. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.
- GEO.G-C.A.4: Geometry Circles Understand and apply theorems about circles. Construct a tangent line from a point outside a given circle to the circle.

Unit 12: Circles I

- **CIRCLE BASICS**
  - GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
  - GEO.G-C.A.2: Geometry Circles Understand and apply theorems about circles. Identify and describe relationships among inscribed angles, radii, and chords. 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.
- **CENTRAL ANGLES, INSCRIBED ANGLES, AND CHORDS**
  - GEO.G-C.A.2: Geometry Circles Understand and apply theorems about circles. Identify and describe relationships among inscribed angles, radii, and chords. 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.
  - GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
  - GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
  - GEO.G-C.B.5: Geometry Circles Find arc lengths and areas of sectors of circles. 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.

Unit 13: Circles II

- **SECANTS, ANGLES, AND INTERCEPTED ARCS**

- GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
- GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
- GEO.G-C.A.2: Geometry Circles Understand and apply theorems about circles. Identify and describe relationships among inscribed angles, radii, and chords. 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.
- GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.

- **TANGENTS, ANGLES, AND INTERCEPTED ARCS**
  - GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
  - GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
  - GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
  - GEO.G-C.A.2: Geometry Circles Understand and apply theorems about circles. Identify and describe relationships among inscribed angles, radii, and chords. 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.
  - GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.

- GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.
- GEO.G-CO.C.9: Geometry Congruence Prove geometric theorems and, when appropriate, the converse of theorems. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segments endpoints.

Unit 14: Properties of Circles

- **CONGRUENT AND SIMILAR CIRCLES**
  - GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
  - GEO.G-C.A.1: Geometry Circles Understand and apply theorems about circles. Prove that all circles are similar.
  - GEO.G-CO.A.4: Geometry Congruence Experiment with transformations in the plane. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
  - GEO.G-CO.B.6: Geometry Congruence Understand congruence in terms of rigid motions. 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.
  - GEO.G-SRT.A.2: Geometry Similarity, Right Triangles, and Trigonometry Understand similarity in terms of similarity transformations. 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.
- **CIRCUMFERENCE AND ARC LENGTH**
  - GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
  - GEO.G-GMD.A.1: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieris principle, and informal limit arguments.
  - GEO.G-GMD.A.1: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument for the formulas for the circumference of a circle,

area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieris principle, and informal limit arguments.

- GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. 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**
  - GEO.G-GMD.A.1: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieris principle, and informal limit arguments.
  - GEO.G-GMD.A.1: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieris principle, and informal limit arguments.
  - GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
  - GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
  - GEO.G-CO.A.5: Geometry Congruence Experiment with transformations in the plane. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Unit 15: Conic Sections

- **CIRCLES**
  - GEO.G-CO.A.1: Geometry Congruence Experiment with transformations in the plane. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
  - GEO.G-GPE.A.1: Geometry Expressing Geometric Properties with Equations Translate between the geometric description and the equation for a conic section. 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.
- **PARABOLAS**
  - GEO.G-GMD.B.4: Geometry Geometric Measurement and Dimension Visualize relationships between two-dimensional and three-dimensional objects. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

- GEO.G-GPE.A.2: Geometry Expressing Geometric Properties with Equations Translate between the geometric description and the equation for a conic section. Derive the equation of a parabola given a focus and directrix.

Unit 16: Surface Area

- **SURFACE AREA AND VOLUME OF SPHERES**
  - GEO.G-GMD.A.2: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.
  - GEO.G-GMD.A.3: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.
  - GEO.G-GMD.B.4: Geometry Geometric Measurement and Dimension Visualize relationships between two-dimensional and three-dimensional objects. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
  - GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. 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**
  - GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. 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**
  - GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

Unit 17: Volume

- **RELATING TWO-DIMENSIONAL FIGURES TO THREE-DIMENSIONAL SOLIDS**
  - GEO.G-GMD.B.4: Geometry Geometric Measurement and Dimension Visualize relationships between two-dimensional and three-dimensional objects. 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**
  - GEO.G-GMD.A.2: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.

- GEO.G-GMD.A.1: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieris principle, and informal limit arguments.
- GEO.G-GMD.A.2: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.
- GEO.G-GMD.A.3: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.
- GEO.G-GMD.B.4: Geometry Geometric Measurement and Dimension Visualize relationships between two-dimensional and three-dimensional objects. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
- GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
- GEO.G-GMD.A.1: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieris principle, and informal limit arguments.
- GEO.G-GMD.A.2: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.

- **VOLUME OF CYLINDERS AND CONES**
  - GEO.G-GMD.A.1: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieris principle, and informal limit arguments.
  - GEO.G-GMD.A.2: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.
  - GEO.G-GMD.A.3: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.
  - GEO.G-GMD.A.1: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieris principle, and informal limit arguments.

- GEO.G-GMD.A.2: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.
- GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
- GEO.G-GMD.A.1: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieris principle, and informal limit arguments.
- GEO.G-GMD.A.2: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.
- GEO.G-GMD.B.4: Geometry Geometric Measurement and Dimension Visualize relationships between two-dimensional and three-dimensional objects. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Unit 18: Applications of Volume

- **MODELING SITUATIONS WITH GEOMETRY**
  - GEO.G-MG.A.2: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).
  - GEO.G-MG.A.3: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. 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).
- **VOLUME OF COMPOSITE SOLIDS**
  - GEO.G-MG.A.1: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
  - GEO.G-GMD.A.2: Geometry Geometric Measurement and Dimension Explain volume formulas and use them to solve problems. Give an informal argument using Cavalieris principle for the formulas for the volume of a sphere and other solid figures.

Unit 19: Basic Probability Concepts

- **INTRODUCTION TO PROBABILITY**
  - GEO.S-CP.A.2: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Understand that two events A and B are independent if the probability of

A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.

- GEO.S-CP.B.8: Statistics and Probability Conditional Probability and the Rules of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model. Apply the general Multiplication Rule in a uniform probability model, (and) = ()() = ()(), and interpret the answer in terms of the model.
- GEO.S-CP.A.5: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.
- GEO.S-CP.B.8: Statistics and Probability Conditional Probability and the Rules of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model. Apply the general Multiplication Rule in a uniform probability model, (and) = ()() = ()(), and interpret the answer in terms of the model.
- GEO.S-CP.A.1: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (or, and, not).
- GEO.S-CP.B.7: Statistics and Probability Conditional Probability and the Rules of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model. Apply the Addition Rule, (or) = () + () (and), and interpret the answer in terms of the model.

- **COMBINATIONS AND PERMUTATIONS**
  - GEO.S-CP.B.9: Statistics and Probability Conditional Probability and the Rules of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model. Use permutations and combinations to compute probabilities of compound events and solve problems.

Unit 20: Advanced Probability Concepts

- **CONDITIONAL PROBABILITY**
  - GEO.S-CP.A.3: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Understand the conditional probability of given as (and)/(), and interpret independence of and as saying that the conditional probability of given is the same as the probability of , and the conditional probability of given is the same as the probability of .
  - GEO.S-CP.A.5: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.
  - GEO.S-CP.B.6: Statistics and Probability Conditional Probability and the Rules of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model. Find

the conditional probability of given as the fraction of s outcomes that also belong to , and interpret the answer in terms of the model.

- GEO.S-CP.A.2: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.
- GEO.S-CP.A.3: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Understand the conditional probability of given as (and)/(), and interpret independence of and as saying that the conditional probability of given is the same as the probability of , and the conditional probability of given is the same as the probability of .
- GEO.S-CP.B.6: Statistics and Probability Conditional Probability and the Rules of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model. Find the conditional probability of given as the fraction of s outcomes that also belong to , and interpret the answer in terms of the model.
- GEO.S-CP.A.4: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. 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.
- GEO.S-CP.A.1: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (or, and, not).
- GEO.S-CP.A.3: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Understand the conditional probability of given as (and)/(), and interpret independence of and as saying that the conditional probability of given is the same as the probability of , and the conditional probability of given is the same as the probability of .
- GEO.S-CP.B.6: Statistics and Probability Conditional Probability and the Rules of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model. Find the conditional probability of given as the fraction of s outcomes that also belong to , and interpret the answer in terms of the model.
- GEO.S-CP.A.3: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Understand the conditional probability of given as (and)/(), and interpret independence of and as saying that the conditional probability of given is the same as the probability of , and the conditional probability of given is the same as the probability of .

- GEO.S-CP.B.6: Statistics and Probability Conditional Probability and the Rules of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model. Find the conditional probability of given as the fraction of s outcomes that also belong to , and interpret the answer in terms of the model.
- GEO.S-CP.A.3: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Understand the conditional probability of given as (and)/(), and interpret independence of and as saying that the conditional probability of given is the same as the probability of , and the conditional probability of given is the same as the probability of .
- GEO.S-CP.B.6: Statistics and Probability Conditional Probability and the Rules of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model. Find the conditional probability of given as the fraction of s outcomes that also belong to , and interpret the answer in terms of the model.

- **GEOMETRIC PROBABILITIES**
  - GEO.G-MG.A.3: Geometry Modeling with Geometry Apply geometric concepts in modeling situations. 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).
  - GEO.S-CP.A.1: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (or, and, not).
  - GEO.S-CP.B.7: Statistics and Probability Conditional Probability and the Rules of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model. Apply the Addition Rule, (or) = () + () (and), and interpret the answer in terms of the model.
  - GEO.S-CP.A.1: Statistics and Probability Conditional Probability and the Rules of Probability Understand independence and conditional probability and use them to interpret data from simulations or experiments. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (or, and, not).
  - GEO.S-CP.B.7: Statistics and Probability Conditional Probability and the Rules of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model. Apply the Addition Rule, (or) = () + () (and), and interpret the answer in terms of the model.
- **ANALYZING DECISIONS IN PROBABILITY**