

Model Curriculum Geometry Units

Mathematics Model Curriculum: Geometry Overview

Moving towards formal mathematical arguments, the standards presented in this high school geometry course are meant to formalize and extend middle grades geometric experiences. Transformations are presented early in the year to assist with the building of conceptual understandings of the geometric concepts.

In unit 1, triangle congruence conditions are established using analysis of rigid motion and formal constructions. Various formats will be used to prove theorems about angles, lines, triangles and other polygons. The work in unit 2 will build on the students understanding of dilations and proportional reasoning to develop a formal understanding of similarity.

The standards included in unit 3 extend the notion of similarity to right triangles and the understanding of right triangle trigonometry. In developing the Laws of Sines and Cosines, the students are expected to find missing measures of triangles in general, not just right triangles.

Work in unit 4 will focus on circles and using the rectangular coordinate system to verify geometric properties and to solve geometric problems. Concepts of similarity will be used to establish the relationship among segments on chords, secants and tangents as well as to prove basic theorems about circles.

The standards in unit 5 will extend previous understandings of two- dimensional objects in order to explain, visualize, and apply geometric concepts to three-dimensional objects. Informal explanations of circumference, area and volume formulas will be analyzed.

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Major **Supporting** **Additional** (Identified by PARCC: revised High School Model Content Frameworks for Mathematics)

Bold type indicates grade level fluency requirements. (Identified by PARCC: revised High School Model Content Frameworks for Mathematics)

Modeling Standards *Specific modeling standards appear throughout the high school standards indicated by a star symbol (★).* (Identified from COMMON CORE STATE STANDARDS for Mathematics pg. 73).

Additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics is indicated by (+) (Identified from COMMON CORE STATE STANDARDS for Mathematics pg. 57).

Unit 1: Congruence, Proof, and Constructions

Experiment with transformations in the plane.	G.CO.1	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.
	G.CO.2	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).
	G.CO.3	Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.
	G.CO.4	Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
	G.CO.5	Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
Understand Congruence in terms of rigid motions.	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.
	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.
	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.
Prove geometric theorems.	G.CO.9	Prove theorems about lines and angles. <i>Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.</i>
	G.CO.10	Prove theorems about triangles. <i>Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.</i>
	G.CO.11	Prove theorems about parallelograms. <i>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.</i>
Make Geometric Constructions	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.). <i>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.</i>
	G.CO.13	Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Unit 2: Similarity and Proof

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Use coordinates to prove simple geometric theorems algebraically.	G.GPE.6	Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
Understand similarity in terms of similarity transformations.	G.SRT.1	Verify experimentally the properties of dilations given by a center and a scale factor. a. 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. b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.
	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.
	G.SRT.3	Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.
Prove geometric theorems.	G.CO.10	Prove theorems about triangles. <i>Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.</i>
Understand and apply theorems about circles	G.C.1	Prove that all circles are similar.

Unit 3: Trigonometry

Use coordinates to prove simple geometric theorems algebraically.	G.GPE.6	Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
Prove theorems involving similarity.	G.SRT.4	Prove theorems about triangles. <i>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.</i>
	G.SRT.5	Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
Define trigonometric ratios and solve problems involving right triangles.	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.
	G.SRT.7	Explain and use the relationship between the sine and cosine of complementary angles.
	G.SRT.8	Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*
Apply trigonometry to general triangles.	G.SRT.9	(+) Derive the formula $A = \frac{1}{2} ab \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.
	G.SRT.10	(+) Prove the Laws of Sines and Cosines and use them to solve problems.
	G.SRT.11	(+) 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).

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Unit 4: Circles and Expressing Geometric Properties through Equations

Understand and apply theorems about circles.	G.C.2	Identify and describe relationships among inscribed angles, radii, and chords. <i>Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.</i>
	G.C.3	Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.
	G.C.4	(+) Construct a tangent line from a point outside a given circle to the circle.
Find arc lengths and areas of sectors of circles.	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.
Translate between the geometric description and the equation of a conic section.	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
Prove geometric theorems.	G.CO.11	Prove theorems about parallelograms. <i>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.</i>
Use coordinates to prove simple geometric theorems algebraically.	G.GPE.4	Use coordinates to prove simple geometric theorems algebraically. <i>For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point $(0, 2)$.</i>
	G.GPE.5	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.
	G.GPE.7	Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.★
Apply geometric concepts in modeling situations.	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). ★

Unit 5: Extending to Three Dimensions

Explain volume formulas and use them to solve problems.	G.GMD.1	Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. <i>Use dissection arguments, Cavalieri's principle, and informal limit arguments.</i>
	G.GMD.3	Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.★
Visualize the relation between two-dimensional and three-dimensional objects.	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.
Apply geometric concepts in modeling situations.	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). ★
Apply geometric concepts in modeling situations.	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). ★
	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). ★