Mendham Township School District

Mathematics Curriculum - 2012

Honors Geometry

The fundamental purpose of the course in Geometry is to formalize and extend students' geometric experiences from the middle grades. Students explore more complex geometric situations and deepen their explanations of geometric relationships, moving towards formal mathematical arguments. Important differences exist between this Geometry course and the historical approach taken in Geometry classes. For example, transformations are emphasized early in this course. Close attention should be paid to the introductory content for the Geometry conceptual category found in the high school CCSS. The Mathematical Practice Standards apply throughout each course and, together with the content standards, prescribe that students experience mathematics as a coherent, useful, and logical subject that makes use of their ability to make sense of problem situations. The critical areas, organized into six units are as follows.

Critical Area 1: In previous grades, students were asked to draw triangles based on given measurements. They also have prior experience with rigid motions: translations, reflections, and rotations and have used these to develop notions about what it means for two objects to be congruent. In this unit, students establish triangle congruence criteria, based on analyses of rigid motions and formal constructions. They use triangle congruence as a familiar foundation for the development of formal proof. Students prove theorems—using a variety of formats—and solve problems about triangles, quadrilaterals, and other polygons. They apply reasoning to complete geometric constructions and explain why they work.

Critical Area 2: Students apply their earlier experience with dilations and proportional reasoning to build a formal understanding of similarity. They identify criteria for similarity of triangles, use similarity to solve problems, and apply similarity in right triangles to understand right triangle trigonometry, with particular attention to special right triangles and the Pythagorean theorem. Students develop the Laws of Sines and Cosines in order to find missing measures of general (not necessarily right) triangles, building on students' work with quadratic equations done in the first course. They are able to distinguish whether three given measures (angles or sides) define 0, 1, 2, or infinitely many triangles.

Critical Area 3: Students' experience with two-dimensional and three-dimensional objects is extended to include informal explanations of circumference, area and volume formulas. Additionally, students apply their knowledge of two-dimensional shapes to consider the shapes of cross-sections and the result of rotating a two-dimensional object about a line.

Critical Area 4: Building on their work with the Pythagorean theorem in 8th grade to find distances, students use a rectangular coordinate system to verify geometric relationships, including properties of special triangles and quadrilaterals and slopes of parallel and perpendicular lines, which relates back to work done in the first course. Students continue their study of quadratics by connecting the geometric and algebraic definitions of the parabola.

Critical Area 5: In this unit students prove basic theorems about circles, such as a tangent line is perpendicular to a radius, inscribed angle theorem, and theorems about chords, secants, and tangents dealing with segment lengths and angle measures. They study relationships among segments on chords, secants, and tangents as an application of similarity. In the Cartesian coordinate system, students use the distance formula to write the equation of a circle when given the radius and the coordinates of its center. Given an equation of a circle, they draw the graph in the coordinate plane, and apply techniques for solving quadratic equations, which relates back to work done in the first course, to determine intersections between lines and circles or parabolas and between two circles.

Critical Area 6: Building on probability concepts that began in the middle grades, students use the languages of set theory to expand their ability to compute and interpret theoretical and experimental probabilities for compound events, attending to mutually exclusive events, independent events, and conditional probability.

<table>
<tr><th>Units</th><th>Includes Standard Clusters*</th><th>Mathematical Practice Standards</th></tr>
<tr><td>Unit 1
Congruence, Proof, and Constructions</td><td>• Experiment with transformations in the plane.
• Understand congruence in terms of rigid motions.
• Prove geometric theorems.
• Make geometric constructions.</td><td rowspan="6">Make sense of problems and persevere in solving them.

Reason abstractly and quantitatively.

Construct viable arguments and critique the reasoning of others.

Model with mathematics.

Use appropriate tools strategically.

Attend to precision.

Look for and make use of structure.

Look for and express regularity in repeated reasoning.</td></tr>
<tr><td>Unit 2
Similarity, Proof, and Trigonometry</td><td>• Understand similarity in terms of similarity transformations.
• Prove theorems involving similarity.
• Define trigonometric ratios and solve problems involving right triangles.
• Apply geometric concepts in modeling situations.
• Apply trigonometry to general triangles.</td></tr>
<tr><td>Unit 3
Extending to Three Dimensions</td><td>• Explain volume formulas and use them to solve problems.
• Visualize the relation between two-dimensional and three-dimensional objects.
• Apply geometric concepts in modeling situations.</td></tr>
<tr><td>Unit 4
Connecting Algebra and Geometry through Coordinates</td><td>• Use coordinates to prove simple geometric theorems algebraically.
• Translate between the geometric description and the equation for a conic section.</td></tr>
<tr><td>Unit 5
Circles With and Without Coordinates</td><td>• Understand and apply theorems about circles.
• Find arc lengths and areas of sectors of circles.
• Translate between the geometric description and the equation for a conic section.
• Use coordinates to prove simple geometric theorem algebraically.
• Apply geometric concepts in modeling situations.</td></tr>
<tr><td>Unit 6
Applications of Probability</td><td>• Understand independence and conditional probability and use them to interpret data.
• Use the rules of probability to compute probabilities of compound events in a uniform probability model.
• Use probability to evaluate outcomes of decisions.</td></tr>
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Based Upon “Common Core” 2010

The following chart details the Geometry curricular focus and is broken out into areas of content, skills, and concepts:

Unit 1: Congruence, Proof, and Constructions

In previous grades, students were asked to draw triangles based on given measurements. They also have prior experience with rigid motions: translations, reflections, and rotations and have used these to develop notions about what it means for two objects to be congruent. In this unit, students establish triangle congruence criteria, based on analyses of rigid motions and formal constructions. They use triangle congruence as a familiar foundation for the development of formal proof. Students prove theorems—using a variety of formats—and solve problems about triangles, quadrilaterals, and other polygons. They apply reasoning to complete geometric constructions and explain why they work.

UNIT ONE CCS	CCCS#	Comp & Content	Skills	Concepts
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.	GCO1	Define point, line, distance along a line, and distance around a circular arc.	Develop definitions for angles, circles, parallel lines, perpendicular lines, and line segments.	
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).	GCO2		Describe all transformations as functions that take points in the plane as inputs and give other points as outpoints.	Compare rigid and non-rigid transformations.
Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.	GC03		Describe compound transformations that map geometric figures onto themselves.	
Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments	GCO4	Define rotations, reflections, and translations, parallel lines, perpendicular lines, and line segments.	Apply the definitions of angles, circles, parallel lines, perpendicular lines, and line segments to describe rotations, reflections, and translations.	Develop and perform rigid transformations that include reflections, rotations, and translations using different modalities and compare to non-rigid transformations.
Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or	GCO5		Draw rigid transformations using multiple modalities.	Specify a sequence of rigid transformations carry a given figure

geometry software. Specify a sequence of transformations that will carry a given figure onto another.				onto another.
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	GCO6	Define congruence.		
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.	GCO7	Define corresponding sides and corresponding angles.	Use the definition of congruence and rigid motions to show that two triangles are congruent.	
Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions	GCO8	Define ASA, SAS, and SSS.	Determine if triangles meet the definition of congruence using corresponding parts.	Prove triangle congruence using ASA, SAS, and SSS.
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; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.	GC09	Define vertical angles, transversals, alternate interior angles, corresponding angles, perpendicular bisector of a line segment, equidistance, and endpoints.		Develop a rule for angle relationships given parallel lines intersected by a transversal and prove theorems about lines and angles.
Prove theorems about triangles. 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.	GC010	Define interior angles of a triangle, base angles of an isosceles triangle, and midpoints and medians of a triangle.	Use triangle theorems to find angle measures.	Prove theorems about triangles.
Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely,	GCO11	Define parallelograms, rectangles, rhombuses, squares, opposite sides, opposite angles, diagonals,	Use properties of parallelograms to find angle measures and side lengths.	Prove theorems about parallelograms.

rectangles are parallelograms with congruent diagonals.		and the term conversely.		
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.	GCO12		Make formal geometric constructions with a variety of tools and methods.	
Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.	GCO13		Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.	

Unit 2: Similarity, Proof, and Trigonometry

Students apply their earlier experience with dilations and proportional reasoning to build a formal understanding of similarity. They identify criteria for similarity of triangles, use similarity to solve problems, and apply similarity in right triangles to understand right triangle trigonometry, with particular attention to special right triangles and the Pythagorean Theorem. Students develop the Laws of Sines and Cosines in order to find missing measures of general (not necessarily right) triangles. They are able to distinguish whether three given measures (angles or sides) define 0, 1, 2, or infinitely many triangles.

UNIT TWO CCS	CCCS#	Comp & Content	Skills	Concepts
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, an 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	GSRT1	Define dilation and scale factor.	Explore relationships between dilations and scale factor. Determine scale factor.	

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.	GSRT2	Define similarity.	Determine similarity using corresponding sides and proportionality.	
Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.	GSRT3			Determine the AA criteria for two triangles to be similar.
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.*	GSRT4	Define the Pythagorean Theorem.	Use the Pythagorean Theorem and a line parallel to one side of a triangle to find missing side lengths.	Prove the Pythagorean Theorem and theorems involving triangle similarity.
Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.	GSRT5		Use congruence and similarity theorems for triangles to solve real-world problems.	Prove relationships in geometric figures.

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.	GSRT6	Define triangle ratios for acute angles. Define geometric mean.	Use similarity to determine side ratios in right triangles.	
Explain and use the relationship between the sine and cosine of complementary angles.	GSRT7			Determine the relationship between Sin θ and 90 – Sin θ.
Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.	GSRT8		Use trigonometric ratios and the Pythagorean Theorem to solve right triangles.	
Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).	GMG1		Use geometric shapes to describe three dimensional objects in a real-world context.	
Apply concepts of density based on area and volume in modeling situations (e.g., persons per	GMG2	Define density, area, and volume.	Apply density based on area and volume in	

square mile, BTUs per cubic foot).			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).	GMG3		Apply geometric methods to solve problems involving scale.	Design an object or structure to satisfy physical constrains constraints or to determine the maximum/minimum regarding area, volume, and/or costs.
Derive the formula $A = 1/2\ ab \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.	GSRT9	Define an oblique triangle.	Use a formula to find the area of an oblique triangle.	Derive the formula for finding the area of an oblique triangle.
Prove the Laws of Sines and Cosines and use them to solve problems.	GSRT10	Define the Law of Sines and the Law of Cosines.	Use the Law of Sines and the Law of Cosines to solve non-right triangles.	Prove the Law of Sines and the Law of Cosines.
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).	GSRT11		Apply the Law of Sines and the Law of Cosines to solve real-world problems.	

Unit 3: Extending to Three Dimensions

Students' experience with two-dimensional and three-dimensional objects is extended to include informal explanations of circumference, area and volume formulas. Additionally, students apply their knowledge of two-dimensional shapes to consider the shapes of cross-sections and the result of rotating a two-dimensional object about a line.

UNIT THREE CCS	CCCS#	Comp & Content	Skills	Concepts
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, Cavalieri's principle, and informal limit arguments.*	GGMD1	Define the area and circumference of a circle. Define the volume of a prism, cylinder, pyramid, and cone. Define Cavalier's principle.		
Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.	GGMD3	Define sphere.	Use volume formulas for prisms, cylinders, pyramids, cones, and spheres to problem solve.	
Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.	GGMD4	Define cross section.	Visualize and identify two-dimensional cross sections of three-dimensional objects. Visualize and identify three-dimensional objects generated by rotations of two-dimensional objects.	
Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).	GMG1		Use geometric shapes, their measures, and their properties to describe objects.	

Unit 4: Connecting Algebra and Geometry Through Coordinates

Building on their work with the Pythagorean theorem in 8th grade to find distances, students use a rectangular coordinate system to verify geometric relationships, including properties of special triangles and quadrilaterals and slopes of parallel and perpendicular lines. Students continue their study of quadratics by connecting the geometric and algebraic definitions of the parabola.

UNIT FOUR CCS	CCCS#	Comp & Content	Skills	Concepts
Use coordinates to prove simple geometric theorems algebraically. *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, √3) lies on the circle centered at the origin and containing the point (0, 2).*	GGPE4	Define coordinate plane. Define slope.	Use the distance formula and slope to prove theorems about geometric shapes 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).	GGPE5		Find the equation of a line parallel and perpendicular to a given line and passing through a given point.	Prove slope of parallel and perpendicular lines using coordinate geometry.

Find the point on a directed line segment between two given points that partitions the segment in a given ratio.	GGPE6		Use a given ratio to find a point on a directed line segment between two given points.	
Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula	GGPE7		Use the distance formula and given coordinates to determine the perimeter of polygons and the area of triangles and rectangles.	
Derive the equation of a parabola given a focus and directrix.	GGPE2			Derive the equation of a parabola given a focus and directrix.

Unit 5: Circles With and Without Coordinates

In this unit, students prove basic theorems about circles, with particular attention to perpendicularity and inscribed angles, in order to see symmetry in circles and as an application of triangle congruence criteria. They study relationships among segments on chords, secants, and tangents as an application of similarity. In the Cartesian coordinate system, students use the distance formula to write the equation of a circle when given the radius and the coordinates of its center. Given an equation of a circle, they draw the graph in the coordinate plane, and apply techniques for solving quadratic equations to determine intersections between lines and circles or parabolas and between two circles.

UNIT FIVE CCS	CCCS#	Comp & Content	Skills	Concepts
Prove that all circles are similar.	GC1			Prove that all circles are similar using ratios.
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.*	GC2	Identify: inscribed angles, radii, cords, central angles, inscribed angles, circumscribed angles, diameter, and tangent.	Describe the relationships among inscribed angles, radii, cords, central angles, inscribed angles, circumscribed angles, diameter, and tangent. Show that inscribed angles on a diameter are right angles and that the radius of a circle is perpendicular to the tangent where the radius intersects the circle.	
Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.	GC3		Construct the inscribed and circumscribed circles of a triangle.	Prove properties of angles for a quadrilateral inscribed in a circle.
Construct a tangent line from a point outside a given circle to the circle.	GC4		Construct a tangent line from a point outside a given circle to the circle.	

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.	GC5	Define arc length, intercepting angle, radian measure, and sector.	Find arc length and the area of a sector.	Derive the formula for finding the arc length and the area of a sector.
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.	GGPE1		Determine the radius and center of a circle given its standard form. Complete the square to find the center and radius of a circle given by an equation.	Derive the area of a circle using the Pythagorean Theorem.
Use coordinates to prove simple geometric theorems algebraically. *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, √3) lies on the circle centered at the origin and containing the point (0, 2).*	GGPE4		Use coordinates to prove simple geometric theorems algebraically.	
Use geometric shapes, their measures, and their	GMG1		Use geometric shapes,	

properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).			their measures, and their properties to describe objects.	

Unit 6: Applications of Probability

Building on probability concepts that began in the middle grades, students use the languages of set theory to expand their ability to compute and interpret theoretical and experimental probabilities for compound events, attending to mutually exclusive events, independent events, and conditional probability. Students should make use of geometric probability models wherever possible. They use probability to make informed decisions.

UNIT SIX CCS	CCCS#	Comp & Content	Skills	Concepts
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").	SCP1	Define subsets, sample space, outcomes, unions, intersections, complements. Know set notation.	Use a Venn diagram or words to show all possible logical relations between a finite collection of sets (aggregation of things).	
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.	SCP2		Determine if compound events are independent or dependent.	
Understand the conditional probability of *A*	SCP3	Define conditional	Compare conditional	Interpret the

given *B* as *P*(*A* and *B*)/*P*(*B*), and interpret independence of *A* and *B* as saying that 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*.		probability.	probabilities.	independence conditional probability.
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. *For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*	SCP4	Identify two-way frequency tables of data.	Construct, interpret, and use two-way frequency tables (after collecting data) as a sample space to decide if events are independent and to approximate conditional probabilities.	
Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. *For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.*	SCP5		Recognize and calculate conditional probability given real-world data.	

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 terms of the model.	SCP6		Use conditional probability to determine probability.	Interpret conditional probability items of the model.
Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.	SCP7		Apply the Addition Rule.	Interpret the Addition Rule in terms of the model.
Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.	SCP8		Apply the Multiplication Rule.	Interpret the Multiplication Rule in terms of the model.
Use permutations and combinations to compute probabilities of compound events and solve problems.	SCP9		Use permutations and combinations to compute probabilities of compound events and solve real-world problems.	

Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).	SMD6	Define random samples.	Use simple probability to make fair decisions.	
Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).	SMD7			Analyze real-world concepts using probability