Honors Geometry Curriculum Maps

Grade: 9/10 Subject: Honors Geometry	Unit 1: Congruence, Proof, and Constructions
Big Idea/Rationale	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.
Enduring Understanding (Mastery Objective)	• Congruence is directly connected to isometric transformations. • Protractors, compasses, and rulers can be used to construct geometric figures. • Symmetry in a figure implies congruence of sides and angles. • Transformations in geometry will be used to establish all the important geometric principles. • Sequences of isometric transformations can map one figure to another figure if those figures are congruent. • Proofs are used to establish the validity of geometric relationships by using deductive reasoning in a format other people can follow. • Properties of congruent triangles are used in mathematical proofs. • Triangles have special properties that allow you to use shortcuts for proving congruence. • All polygons can be divided into triangles so the proofs of triangles are used in other figures as well. • Constructions connect the theory to a practical physical medium.
Essential Questions (Instructional Objective)	• How do we write precise definitions for geometric terms? • What are geometric constructions? • What is a transformation? What different types of transformations exist? • What relationships exist between angles formed by a transversal over two parallel lines? • How do we write geometric proofs? • What does it mean for two triangles to be congruent? • What are some of the shortcuts that can be used for proving triangle congruence? • What are some of the special properties of isosceles and equilateral triangles? • How do triangles relate to the sum of the angle measures in polygons? • How can we prove a figure is a parallelogram? • What properties do rhombuses, rectangles, and squares share? • How are kites and trapezoids the same as other quadrilaterals? How are they

	different?
Content (Subject Matter)	• Experiment with transformations in the plane. • Understand congruence in terms of rigid motions. • Prove geometric theorems relating to angles, triangles, and quadrilaterals. • Make geometric constructions.
Skills/ Benchmarks (CCSS Standards)	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. 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. G.CO.9. 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.* G.CO.10. 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.* G.CO.11. 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.* G.CO.12. Make formal geometric constructions with a variety of tools and

	methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). *Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.* G.CO.13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.
Materials and Resources	Document camera, Computer/Laptop, Common Core Resources, Holt Geometry Textbook and Supplementary Materials, Compass, Protractor, Ruler, Geometer's Sketchpad, Patty Paper, Calculators, Teacher Created Notes and Worksheets
Notes	

<table>
<tr><td>Grade: 9/10
Subject: Honors Geometry</td><td>Unit 2: Similarity, Proof, and Trigonometry</td></tr>
<tr><td>Big Idea/Rationale</td><td>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.</td></tr>
<tr><td>Enduring Understanding (Mastery Objective)</td><td>• Dilations are non-isometric transformations which are used to establish similarity.
• Similar polygons are used in building models of real objects and in the design of bridges and towers.
• Ratios and proportions are at the heart of similarity.
• Proportional reasoning is used in indirect measurement.
• The Pythagorean Theorem and special right triangles have many applications in real-world situations.
• Similarity relationships in right triangles and geometric means are used to estimate distances in surveying, architecture, and highway design.
• Trigonometric ratios can be used to find angle measures in right triangles and are used in indirect measurement and with vectors.
• Many real-world problems require that you find the unknown lengths and angle measures in a right triangle.
• Angles of elevation and depression can be used to calculate distances.
• You can use the Law of Sines and the Law of Cosines to solve any triangle-not just right triangles.</td></tr>
<tr><td>Essential Questions (Instructional Objective)</td><td>• Are there similarities in right triangles? How do we use similar right triangles?
• How can we find measurements indirectly?
• Where can I use trigonometry in the real-world?
• How can I use angles to calculate distance?
• Are there rules for finding missing information about triangles that are not right triangles?
• What are vectors used for in real-world situations?</td></tr>
<tr><td>Content
(Subject Matter)</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.</td></tr>
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	• Apply trigonometry to general triangles.
Skills/ Benchmarks (CCSS Standards)	N.VM.A.1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., ***v***, |***v***|, ||***v***||, *v*). N.VM.A.2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. N.VM.A.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors. N.VM.B.4.A. (+) Add and subtract vectors. a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. c. Understand vector subtraction ***v*** - ***w*** as ***v*** + (-***w***), where -***w*** is the additive inverse of ***w***, with the same magnitude as ***w*** and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise. N.VM.B.5. (+) Multiply a vector by a scalar. a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$. b. Compute the magnitude of a scalar multiple $c\mathbf{v}$ using $\|\|c\mathbf{v}\|\| = \|c\|\mathbf{v}$. Compute the direction of $c\mathbf{v}$ knowing that when $\|c\|\mathbf{v} \neq 0$, the direction of $c\mathbf{v}$ is either along $\mathbf{v}$ (for $c > 0$) or against $\mathbf{v}$ (for $c < 0$). 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. G.SRT.4. 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*. G.SRT.5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures. 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.★ G.SRT.9. (+) 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. 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). 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).* 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).*
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Grade: 9/10 Subject: Honors Geometry	**Unit 3: Extending to Three Dimensions**
Big Idea/Rationale	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.
Enduring Understanding (Mastery Objective)	• Previous 2-dimensional geometric concepts can be used to derive formulas in 3-dimensions, both formally and informally. • Nets and cross sections of three-dimensional figures can be used to create models. • Architects use drawings of three-dimensional figures to represent plans for buildings. • Volume can be used in a variety of real-world application including finding the capacity of a swimming pool or amount of air required to fill a balloon.
Essential Questions (Instructional Objective)	• How does the volume of a figure relate to the area of its base? • What does Cavalieri's Principle tell us about volumes? • What is the relationship of volumes of prisms and cylinders with cones and pyramids? • How can we create 3D figures by rotating two-dimensional object? • How can we use geometric shapes to describe real-world objects?
Content (Subject Matter)	• 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.
Skills/ Benchmarks (CCSS Standards)	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. *Use dissection arguments, Cavalieri's principle, and informal limit arguments.* G.GMD.2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures. G.GMD.3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.★ 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. 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).*
Materials and Resources	Document camera, Computer/Laptop, Common Core Resources, Holt Geometry Textbook and Supplementary Materials, Compass, Protractor, Ruler,

	Geometer’s Sketchpad, Patty Paper, Calculators, Teacher Created Notes and Worksheets
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Grade: 9/10 **Subject: Honors Geometry**	**Unit 4: Circles With and Without Coordinates**
Big Idea/Rationale	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.
Enduring Understanding (Mastery Objective)	• No matter what the size of the circle, the circumference divided by the radius is pi. • You can use relationships of segments, arcs, and angles in circles to solve problems. • Circle constructions can help us to visualize properties and definitions. • To better understand popular fields of study such as ophthalmology and archaeology that use angle and segment relationships in circles. • To take a closer look at real world problems such as using circles in the coordinate plane to plan the location of weather stations, radio towers, and radar devices. • Radian measures are based on length and can help provide a more consistent way to graph circles.
Essential Questions (Instructional Objective)	• What relationship exists between a circle and the lines that intersect it? • What role do arcs and chords play when analyzing circle graphs? • Which careers use circles on a daily basis? • What is the difference between radians and degrees? Where is each used? • Where can circles be used in the real world?
Content (Subject Matter)	• 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.
Skills/ Benchmarks (CCSS Standards)	G.C.1. Prove that all circles are similar. G.C.2. 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.*

	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. 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. 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. G.GPE.4. 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).* 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).*
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Grade: 9/10 Subject: Honors Geometry	**Unit 5: Connecting Algebra and Geometry Through Coordinates**
Big Idea/Rationale	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.
Enduring Understanding (Mastery Objective)	• Coordinate geometry links geometric properties to the coordinate plane. • Conic sections allow us to understand 3-Dimensional figures in 2-dimensions. • Slope tells us a lot about different geometric shapes. • When figures are placed in the coordinate plane, there are new ways that can be used to calculate area.
Essential Questions (Instructional Objective)	• What information can we learn about a circle or parabola from its equation? • Why are there different forms of the same equation? • How can we use algebra to verify geometric properties or classify geometric figures? • How does the slope of a line allow us to establish relationships and classifications of figures? • How can we use slope and dilations to partition segments or create similar figures? • What are the different ways we can calculate area for figures in the coordinate plane?
Content (Subject Matter)	• Use coordinates to prove simple geometric theorems algebraically. • Translate between the geometric description and the equation for a conic section.
Skills/ Benchmarks (CCSS Standards)	G.GPE.4. 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).* G.GPE.5. Prove the slope criteria for parallel and perpendicular lines and uses 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.6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio. G.GPE.7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.★ G.GPE.2. Derive the equation of a parabola given a focus and directrix.
Materials and Resources	Document camera, Computer/Laptop, Common Core Resources, Holt Geometry Textbook and Supplementary Materials, Compass, Protractor, Ruler, Geometer's

	Sketchpad, Patty Paper, Calculators, Teacher Created Notes and Worksheets
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Grade: 9/10 **Subject: Honors Geometry**	**Unit 6: Applications to Probability**
Big Idea/Rationale	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.
Enduring Understanding (Mastery Objective)	• Probability is found by dividing an outcome by the sample space. • Independence is based on whether or not a previous event affects another event. • Two-way tables allow us to quickly see relationships and determine independence. • Probability is used in the real-world in a variety of ways. • Tree diagrams can help visualize and solve probability questions involving the sequence of events. • Permutations and combinations allow us to determine the number of events when there are too many to list out.
Essential Questions (Instructional Objective)	• What types of picture and diagrams can we make to visual sample spaces and events? • What does it mean to be mutually exclusive? Independent? Can events be both? • What type of information do two-way tables show? How can we use them to determine independence? • What are the multiplication and addition rules? When do you use each?
Content (Subject Matter)	• 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.
Skills/ Benchmarks (CCSS Standards)	S.CP.1. 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”). S.CP.2. 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. S.CP.3. Understand the conditional probability of *A* 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*.

	S.CP.4. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. *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.* S.CP.5. 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.* S.CP.6. Find the conditional probability of *A* given *B* as the fraction of *B*'s outcomes that also belong to *A*, and interpret the answer in terms of the model. S.CP.7. Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and interpret the answer in terms of the model. S.CP.8. (+) Apply the general Multiplication Rule in a uniform probability model, $P(A \text{ and } B) = P(A)P(B\|A) = P(B)P(A\|B)$, and interpret the answer in terms of the model. S.CP.9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems. S.MD.6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator). S.MD.7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).
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