



# Curriculum & Instruction

SUMMIT PUBLIC SCHOOLS

**Content Area: Mathematics**

**Course: Honors Geometry Geometry (H231)**

**Grade(s): 9-10**

## Course Overview

*This advanced course in geometry is based on Euclidean geometry and includes congruence, similarity, parallelism, perpendicularity, transformations, area, and volume. Coordinates and geometric constructions are integrated throughout the course. Students will construct two column, paragraph, and indirect proofs throughout much of the first semester using definitions and proved theorems. Students are expected to use scientific calculators, and will use additional technology such as Geogebra at appropriate times. Students will have the opportunity to explore mathematical modeling and application throughout the entire course. Students completing this course will take the NJSLA Exams in Geometry.*

*Prerequisite: Algebra 1, performance on a placement test. To enroll in this course, students must meet the eligibility criteria outlined in the student handbook on page 5.*

## New Jersey State Learning Standards

Summit Public Schools curriculum aligns with the [New Jersey Student Learning Standards](#).

### Content Area Standards:

- G.C.A.1. Prove all circles are similar.
- G.C.A.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.A.3. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.
- G.C.A.4. Construct a tangent line from a point outside a given circle to the circle.
- G.C.B.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.CO.A.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.

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- G.CO.A.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.A.3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.
- G.CO.A.4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.
- G.CO.A.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.B.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.B.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.B.8. Explain how the criteria for a triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.
- G.CO.C.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.C.10. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to  $180^\circ$ ; 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.C.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.D.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.D.13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.
- G.GMD.A.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.A.2+. Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.
- G.GMD.A.3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.
- G.GMD.B.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.GPE.A.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.A.2+. Derive the equation of a parabola given a focus and directrix.
- G.GPE.A.3+. Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.
- G.GPE.B.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  $(1, \sqrt{3})$  lies on the circle centered at the origin and containing the point  $(0, 2)$ .
- G.GPE.B.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.B.7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.
- G.GPE.B.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.MG.A.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.A.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.A.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).
- G.SRT.A.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.A.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.A.3. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.
- G.SRT.B.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.B.5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
- G.SRT.C.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.C.7. Explain and use the relationship between the sine and cosine of complementary angles.
- G.SRT.C.8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

- G.SRT.D.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-D.11+: Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles.
- 7.G.B.6. Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

### Interdisciplinary Standards:

- RI.MF.9–10.6. Analyze, integrate, and evaluate multiple interpretations (e.g., charts, graphs, diagrams, videos) of a single text or text/s presented in different formats (visually, quantitatively) as well as in words in order to address a question or solve a problem.
- RST.9-10.7: Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

### Career Readiness, Life Literacies and Key Skills Standards:

- 9.4.8.CI.3: Examine challenges that may exist in the adoption of new ideas
- 9.4.8.CT.2: Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option
- 9.4.8.DC.7: Collaborate within a digital community to create a digital artifact using strategies such as crowdsourcing or digital surveys.
- 9.1.12.PB.2: Prioritize financial decisions by considering alternatives and possible consequences.
- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving
- 9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.
- 9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).

### Computer Science and Design Thinking Standards:

- 8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.

### Career Readiness Practices

- CRP 1. Act as a responsible and contributing citizen and employee.

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- CRP 2. Apply appropriate academic and technical skills.
- CRP 3. Attend to personal health and financial well-being.
- CRP 4. Communicate clearly and effectively and with reason.
- CRP 5. Consider the environmental, social and economic impacts of decisions.
- CRP 6. Demonstrate creativity and innovation.
- CRP 7. Employ valid and reliable research strategies.
- CRP 8. Utilize critical thinking to make sense of problems and persevere in solving them.
- CRP 9. Model integrity, ethical leadership and effective management.
- CRP 10. Plan education and career paths aligned to personal goals.
- CRP 11. Use technology to enhance productivity.
- CRP 12. Work productively in teams while using cultural global competence.

## New Jersey Curriculum Mandates:

*This curriculum integrates lessons that address the following interdisciplinary New Jersey Curriculum Mandates:*

- [Diversity and Inclusion](#) (Grades K - 12)
  - C.18A:35-4.36a: Curriculum to include instruction on diversity and inclusion.
    - (3) encourage safe, welcoming, and inclusive environments for all students regardless of race or ethnicity, sexual and gender identities, mental and physical disabilities, and religious beliefs.

## Learning Objectives

*Learning objectives are clear, specific statements that define what students should know, understand, and be able to do by the end of a lesson or course.*

### Students will understand that...

- Basic geometric figures are defined by points, lines, and planes. Proper notation is required when naming parts of geometric figures.
- The first column in a two-column proof lists consecutive statements that lead to a conclusion. The second column provides justification for each statement.
- Most statements can be written conditionally, i.e. "if p, then q". The negation, converse, inverse, and contrapositive are formed using varied forms and orders of p and q. Once a statement is written conditionally, it can be structured in a two-column proof.
- Angles are classified by their measure: acute for angles measuring less than 90 degrees, obtuse for angles measuring more than 90 degrees, right if an angle measures exactly 90 degrees, and straight for angles that measure exactly 180 degrees. A pair of angles whose measures add to 90 degrees are called complementary; supplementary if the measures add to 180 degrees. Two congruent angles are angles with the same measure. Perpendicular lines form four right angles. Vertical angles are formed by two intersecting lines; vertical angles have a common vertex yet do not share sides. Vertical angles are congruent.
- The addition, subtraction, multiplication, division, substitution, and transitive properties can be applied using segments and their lengths and angles and their measures.
- Congruent figures are figures that have exactly the same size and shape. All pairs of corresponding parts are congruent.

- There are three postulates (ASA, SAS, and SSS) and one theorem (AAS) that can be used to prove triangles congruent.
- The CPCTC principle states corresponding parts of congruent triangles are congruent.
- The slope of a line is defined by the ratio of the change in y -coordinates to the change in x -coordinates of two points.
- Slope can be positive, negative, zero, or undefined.
- Parallel lines have equal slopes and all vertical lines are parallel. Perpendicular lines have opposite reciprocal slopes.
- Horizontal and vertical lines are perpendicular.
- Two lines are parallel if any of the following are true:
  - Alternate interior angles are congruent.
  - Alternate exterior angles are congruent.
  - Corresponding angles are congruent.
  - Consecutive interior angles are supplementary.
  - Consecutive exterior angles are supplementary.
  - If two lines in the same plane are perpendicular to the same line, then the lines are parallel.
- The special quadrilaterals are parallelograms, rectangles, squares, rhombi, kites, trapezoids, and isosceles trapezoids. They are defined by the properties of their sides, angles, and sometimes diagonals.
- A plane is determined by three noncollinear points, a line and point not on the line, two intersecting lines, or two parallel lines.
- If a line is perpendicular to two distinct lines that lie in a plane and that pass through its foot, then it is perpendicular to the plane.
- Skew lines are lines that are non-parallel and non-coplanar.
- Regular figures are shapes where the angles and the sides are all congruent.
- Similar figures are figures that have the same shape but not necessarily the same size.
- Similar polygons are polygons in which the ratios of the measures of corresponding sides are equal and corresponding angles are congruent.
- For triangles, it is common to use the following theorems: AA~, SSS~, and SAS~.
- The following theorems can be used if two triangles are similar:
  - a. The ratio of the perimeters of two similar polygons equals the ratio of any pair of corresponding sides.
  - If a line is parallel to one side of a triangle and intersects the other two sides, it divides those two sides proportionally.
- In geometry a transformation refers to the change in location and/or size of a figure in the coordinate plane through a series of movements.
- A translation is a transformation where a figure (called a pre-image) is slid on the coordinate plane to a new spot. The new figure is called the image.
- There are four basic types of transformations: reflection, rotation, translation, and dilation.
- All of the types except dilation maintain the shape and size of the original figure, making them congruent.
- In a dilation, the shape of the figure is maintained by the size is changed creating a similar figure.
- In a right triangle, the sum of the squares of the leg is equal to the square of the hypotenuse. This equation can be used to solve for missing side lengths of a right triangle.

- If the acute angles of a right triangle measure  $30^\circ$  and  $60^\circ$ , the sides have ratio  $1 : \sqrt{3} : 2$ . If the acute angles of a right triangle measure  $45^\circ$ , thus forming an isosceles triangle, the sides have ratio  $1 : 1 : \sqrt{2}$ .
- Missing side lengths can be found using proportions with these ratios.
- The sine ratio is defined as the measure of the side opposite the reference angle to the measure of the hypotenuse.
- The cosine ratio is defined as the measure of the side adjacent to the reference angle to the measure of the hypotenuse.
- The tangent ratio is defined as the measure of the opposite side to the measure of the adjacent side.
- To solve problems, students can use proportions and inverse trigonometric functions.
- Every circle has a center.
- By joining the center and any point on the circle, a radius is drawn.
- By joining any two points on a circle, a chord is drawn.
- The longest chord (the diameter) can be constructed by passing through the center of the circle.
- Chords, diameters, and radii create arcs, central angles, and inscribed angles.
- Radii and diameters are also useful in computing and discussing area, circumference, arc length and other related measures.
- After constructing special segments to and in circles, many theorems can be defined, discussed, and proven.
- If a quadrilateral is inscribed in a circle, its opposite angles are supplementary.
- If a parallelogram is inscribed in a circle, it must be a rectangle.
- If the nine-point circle is circumscribed in a triangle, the triangle is equilateral.
- Formulas for area include:
  - Triangle:  $A = \frac{1}{2}bh$
  - Rectangles and Parallelograms:  $A = bh$
  - Squares:  $A = s^2$
  - Trapezoid:  $A = \frac{1}{2}(b_1 + b_2)h$
  - Regular Polygon:  $A = \frac{1}{2}aP$
- If two polygons are similar, the ratio of the area of one polygon to the area of the second polygon is equal to the square of the similarity ratio. Problems can be solved using this idea and proportions.
- The surface area of a three-dimensional figure is the sum of the areas of each surface that forms the exterior of the figure.
- The volume of a prism or cylinder is the product of the area of the base of the figure and the height of the figure.
- The volume of a pyramid or cone is one-third this same product.
- The volume of a prism or cylinder can also be defined as the product of the area of a cross section of the figure and the height of the figure. This is true since a cross section of a prism or cylinder is congruent to the figure's base.
- In a pyramid or cone, the ratio of the area of a cross section to the area of the base equals the square of the ratio of the figures' respective distances from the vertex.

- Coordinate geometry is a branch of geometry where the position of points on a plane is defined with ordered pairs. The ordered pairs form relations, and for the purposes of geometry they will often form familiar shapes.
- Graphing in three dimensions adds an additional axis to the traditional  $x, y$  system. We call the third dimension the  $z$ -axis. Coordinates will have three parts;  $(x, y, z)$ .
- Students will draw a three dimensional coordinate space and then follow the axis to arrive at the point.
- A conic section is a figure formed by the intersection of a plane and a cone.
- Depending on the angle of the plane with respect to the cone, a conic section may be a circle, ellipse, parabola, or hyperbola.

## Units of Study

*Units of study are organized collections of lessons and learning experiences focused on a specific topic and set of skills within a course. Each unit is guided by a set of essential questions.*

### Unit 1: Introduction to Geometry (~12 Days)

- What are the defining characteristics of basic geometric figures?
- How are two-column proofs used in justifying properties or theorems?
- How is logic used to prove or explain mathematical statements?

### Unit 2: Basic Concepts and Proofs (~10 Days)

- How can angles or pairs of angles be defined once two lines, rays, or line segments intersect?
- How are segments and angles and their properties based on measurement used in proof writing?

### Unit 3: Congruent Triangles (~11 Days)

- What are congruent figures?
- How can two triangles be proved congruent?
- If two triangles are congruent, how can additional congruency statements be developed?

### Unit 4: Lines in the Plane (~6 Days)

- How is slope defined?
- What must be true of slopes of parallel and perpendicular lines?

### Unit 5: Parallel Lines and Related Figures (~13 Days)

- How can two lines be proved parallel?
- What are the special quadrilaterals and how are they defined?

### Unit 6: Lines and Planes in Space (~4 Days)

- How is a plane determined?
- How can a line be proved perpendicular to plane?
- How are skew lines determined?

### Unit 7: Polygons and Similarity (~13 Days)

- What are regular figures?

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- What are similar figures?
- How can two polygons be proved similar?
- What are the types of special quadrilaterals?
- If two triangles are similar, how can additional statements (similarity, congruency, and equality) be developed?

#### Unit 8: Transformations (~5 Days)

- What is a transformation?
- How is a transformation done?
- What are the types of transformations?

#### Unit 9: Pythagorean Theorem (~15 Days)

- How is the Pythagorean Theorem used?
- How are special right triangles used to solve problems?
- How can basic right triangle trigonometry be used to solve problems?

#### Unit 10: Circles (~11 Days)

- How are parts of a circle related to one another?
- What relationships are found in circles when tangents, secants, tangent segments, and secant segments, and chords are drawn to and in a circle?
- How does inscribing or circumscribing polygons create new properties?

#### Unit 11: Area (~12 Days)

- How can area be computed?
- How can ratios be used to solve area problems?

#### Unit 12: Surface Area and Volume (~8 Days)

- How are formulas for surface area of three-dimensional figures derived?
- How are formulas for volume of three-dimensional figures derived?
- How can the area of a prism's or cylinder's cross section be used to find a solid's volume?
- How is a cross section of a pyramid or cone used to solve problems?

#### Unit 13: Coordinate Geometry Extended (~7 Days)

- What is coordinate geometry?
- How do you graph in three dimensions?
- What are conic sections?

## Instructional Resources and Materials

*Instructional resources are the information sources teachers utilize to guide their teaching and assessing. Instructional materials are the texts students read or review. The instructional resources and materials may vary in order to meet the learning needs of students.*

- Guided Note Outlines
- [Google Classroom](#)
- [DeltaMath](#)
- [Desmos](#)

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- [Khan Academy](#)
- [NJ Standardized Test Prep Resources](#)
- [Kuta Software](#)
- McDougal, Littell. Geometry, for Enjoyment and Challenge

## Assessment Strategies

*Assessment measures a student's mastery of a course standard and learning objective. Assessment can be used for both instructional purposes and for evaluative purposes. Teachers may choose one or more of the following ideas to assess learners. They may also modify these ideas to make the assessment more responsive to students' interests and needs.*

**Formative:** Practice Problem Sets, Homework Exercises, Exit Tickets, Graded Check-Ins

**Summative:** Quizzes & Unit Tests

**Benchmark:** Midterm and Final Exams

**Alternative:** Projects

## Suggested Strategies for Modification & Differentiation

[Modifications Chart](#)