Geometry Overview

The content standards associated with Geometry are based on the New York State Common Core Learning Standards for Mathematics and the PARCC Model Content Framework for Geometry. The content standards define what students should understand and be able to do at the high school level; the Model Content Framework describes which content is included and emphasized within the Geometry course, specifically. More information about the relationship between the NYS CCLS and the PARCC Model Content Frameworks can be found in this memo.

For high school mathematics, the standards are organized at three levels: *conceptual categories*, *domains* and *clusters*.

Geometry is associated with high school content standards within the *conceptual category* of **Geometry**. This conceptual category contains *domains* of related *clusters* of standards. This chart shows the high school mathematics domains included in Geometry, as well as the corresponding percent of credits on the Geometry Regents Exam:

Conceptual Category	Domains in Geometry	Percent of Test By Credit
Geometry	**Congruence (G-CO)**	**27%-34%**
	Similarity, Right Triangles, and Trigonometry (G-SRT)	**29%-37%**
	Circles (G-C)	**2%-8%**
	Expressing Geometric Properties with Equations (G-GPE)	**12%-18%**
	Geometric Measurement and Dimensions (G-GMD)	**2%-8%**
	Modeling with Geometry (G-GMD)	**8%-15%**

The conceptual category of **Modeling** is also included in Geometry, but is best interpreted not as a collection of isolated topics but rather in relation to other standards:

Modeling	Specific *modeling* domains, clusters, and standards, indicated by a star symbol(★).

For more information about modeling at the high school level, please consult the High School Progression on Modeling.

Not all of the content in a given course is emphasized equally in the standards. The list of content standards for each course is not a flat, one-dimensional checklist; this is by design. There are sometimes strong differences of emphasis even within a single domain. Some clusters require greater emphasis than the others based on the depth of the ideas, the time that they take to master, and/or their importance to future mathematics or the demands of college and career readiness. In addition, an intense focus on the most critical material for each course allows depth in learning, which is carried out through the Standards for Mathematical Practice. Without such focus, attention to the practices would be difficult and unrealistic, as would best practices like formative assessment.

The chart below shows:

- **Clusters and standards associated with Geometry within each domain.** Clusters are identified as ■ Major Content, ▢ Supporting Content, or ◯ Additional Content, to indicate emphasis within the course.

- **NYSED standards clarifications following the applicable standards.** More information about the NYSED standards clarifications can be found here.

Note: The Standards for Mathematical Practice form an important part of the Geometry course, as well:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Mathematics – Geometry

Congruence (G-CO)

◻ **A. Experiment with the transformations in the plane.**

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.

G.CO.A2 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.
NYSED: Trapezoid is defined as "A quadrilateral with at least one pair of parallel sides."

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.

■ **B. Understand congruence in terms of rigid motions.**

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 triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Congruence (G-CO) Continued

■ **C. Prove geometric theorems**.

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.*
NYSED: Theorems include but are not limited to the listed theorems.
Example: theorems that involve complementary or supplementary angles.

G.CO.C.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.*
NYSED: Theorems include but are not limited to the listed theorems.
Example: an exterior angle of a triangle is equal to the sum of the two non-adjacent interior angles of the triangle.

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.*
NYSED: Theorems include but are not limited to the listed theorems.
Example: rhombus is a parallelogram with perpendicular diagonals.

■ **D. Make geometric constructions**.

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.*
NYSED: Constructions include but are not limited to the listed constructions.
Example: constructing the median of a triangle or constructing an isosceles triangle with given lengths.

G.CO.D.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Similarity, Right Triangles and Trigonometry (G-SRT)

■ **A. Understand similarity in terms of similarity transformations**.

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.

■ **B. Prove theorems using similarity.**

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.*
NYSED: Theorems include but are not limited to the listed theorems.
Example: the length of the altitude drawn from the vertex of the right angle of a right triangle to its hypotenuse is the geometric mean between the lengths of the two segments of the hypotenuse.

G.SRT.B.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
NYSED: ASA, SAS, SSS, AAS, and Hypotenuse-Leg (HL) theorems are valid criteria for triangle congruence. AA, SAS, and SSS are valid criteria for triangle similarity.

■ **C. Define trigonometric ratios and solve problems involving right triangles.**

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. ★

Circles (G-C)

A. Understand and apply theorems about circles.

G.C.A.1 Prove that 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.*
NYSED: Relationships include but are not limited to the listed relationships.
Example: angles involving tangents and secants.

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.

B. Find arc lengths and areas of sectors of circles.

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.

Expressing Geometric Properties with Equations (G-GPE)

A. Translate between the geometric description and the equation of a conic section.

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.

B. Use coordinates to prove simple geometric theorems algebraically.

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, √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.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G.GPE.B.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula. ★

Geometric Measurement and Dimension (G-GMD)

o A. Explain volume formulas and use them to solve problems.

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.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.★

o B. Visualize relationships between two-dimensional and three-dimensional objects.

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.

Modeling with Geometry (G-MG) ★

■ A. Apply geometric concepts in modeling situations.

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).

Fluency Recommendations

The PARCC Model Content Frameworks recommend the following fluencies for Geometry students:

G-SRT.5
Fluency with the triangle congruence and similarity criteria will help students throughout their investigations of triangles, quadrilaterals, circles, parallelism, and trigonometric ratios. These criteria are necessary tools in many geometric modeling tasks.

G-GPE.4, 5, 7
Fluency with the use of coordinates to establish geometric results, calculate length and angle, and use geometric representations as a modeling tool are some of the most valuable tools in mathematics and related fields.

G-CO.12
Fluency with the use of construction tools, physical and computational, helps students draft a model of a geometric phenomenon and can lead to conjectures and proofs.