Geometry Overview

Numerals in parentheses designate individual content standards that are eligible for assessment in whole or in part. Underlined numerals (e.g., 1) indicate standards eligible for assessment on two or more end-of-course assessments. For more information, see Tables 1 and 2. Course emphases are indicated by: ■ Major Content; ◘ Supporting Content; ○ Additional Content. Not all CCSSM content standards in a listed domain or cluster are assessed.

Congruence (G-CO)

- ◘ A. Experiment with transformations in the plane (1, 2, 3, 4, 5)
- ■ B. Understand congruence in terms of rigid motions (6, 7, 8)
- ■ C. Prove geometric theorems (9, 10, 11)
- ◘ D. Make geometric constructions (12, 13)

Similarity, Right Triangles, and Trigonometry (G-SRT)

- ■ A. Understand similarity in terms of similarity transformations (1, 2, 3)
- ■ B. Prove theorems involving similarity (4, 5)
- ■ C. Define trigonometric ratios and solve problems involving right triangles (6, 7, 8)

Circles (G-C)

- ○ A. Understand and apply theorems about circles (1, 2, 3)
- ○ B. Find arc lengths and areas of sectors of circles (5)

Expressing Geometric Properties with Equations (G-GPE)

- ○ A. Translate between the geometric description and the equation for a conic section (1)
- ■ B. Use coordinates to prove simple geometric theorems algebraically (4, 5, 6, 7)

Geometric measurement and dimension (G-GMD)

- ○ A. Explain volume formulas and use them to solve problems (1, 3)
- ○ B. Visualize relationships between two-dimensional and three-dimensional objects (4)

Modeling with Geometry (G-MG)

- ■ A. Apply geometric concepts in modeling situations (1, 2, 3)

Mathematical Practices

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.

Examples of Key Advances from Previous Grades or Courses

- Because concepts such as rotation, reflection, and translation were treated in the grade 8 standards mostly in the context of hands-on activities, and with an emphasis on geometric intuition, high school Geometry will put equal weight on precise definitions.

- In grades K-8, students worked with a variety of geometric measures (length, area, volume, angle, surface area, and circumference). In high school Geometry, students apply these component skills in tandem with others in the course of modeling tasks and other substantial applications (MP.4).

- In grade 8, students learned the Pythagorean theorem and used it to determine distances in a coordinate system (8.G.B.6–8). In high school Geometry, students will build on their understanding of distance in coordinate systems and draw on their growing command of algebra to connect equations and graphs of circles (G-GPE.A.1).

- The algebraic techniques developed in Algebra I can be applied to study analytic geometry. Geometric objects can be analyzed by the algebraic equations that give rise to them. Some basic geometric theorems in the Cartesian plane can be proven using algebra.

Discussion of Mathematical Practices in Relation to Course Content

- **Reason abstractly and quantitatively** (MP.2). Abstraction is used in geometry when, for example, students use a diagram of a specific isosceles triangle as an aid to reason about *all* isosceles triangles (G-CO.C.9). Quantitative reasoning in geometry involves the real numbers in an essential way: Irrational numbers show up in work with the Pythagorean theorem (G-SRT.C.8), area formulas often depend (subtly and informally) on passing to the limit and real numbers are an essential part of the definition of dilation (G-SRT.A.1). The proper use of units can help students understand the effect of dilation on area and perimeter (N-Q.A.1).

- **Construct viable arguments and critique the reasoning of others** (MP.3). While all of high school mathematics should work to help students see the importance and usefulness of deductive arguments, geometry is an ideal arena for developing the skill of creating and presenting proofs (G-CO.C.9.10). One reason is that conjectures about geometric phenomena are often about infinitely many cases at once — for example, *every* angle inscribed in a semicircle is a right angle — so that such results cannot be established by checking every case (G-C.A.2).

- **Use appropriate tools strategically** (MP.5). Dynamic geometry environments can help students look for invariants in a whole class of geometric constructions, and the constructions in such environments can sometimes lead to an idea behind a proof of a conjecture.

- **Attend to precision** (MP.6). Teachers might use the activity of creating definitions as a way to help students see the value of precision. While this is possible in every course, the activity has a particularly visual appeal in geometry. For example, a class can build the definition of *quadrilateral* by starting with a rough idea ("four sides"), gradually refining the idea so that it rules out figures that do not fit the intuitive idea. Another place in geometry where precision is necessary and useful is in the refinement of conjectures so that initial conjectures that are not correct can be salvaged — two angle measures and a side length do not determine a triangle, but a certain configuration of these parts leads to the angle-side-angle theorem (G-CO.B.8).

- **Look for and make use of structure** (MP.7). Seeing structure in geometric configurations can lead to insights and proofs. This often involves the creation of auxiliary lines not originally part of a given figure. Two classic examples are the construction of a line through a vertex of a triangle parallel to the opposite side as a way to see that the angle measures of a triangle add to 180 degrees and the introduction of a symmetry line in an isosceles triangle to see that the base angles are congruent (G-CO.C.9, 10). Another kind of hidden structure makes use of area as a device to establish results about proportions, such as the important theorem (and its converse) that a line parallel to one side of a triangle divides the other two sides proportionally (G-SRT.B.4).

Fluency Recommendations

G-SRT.B.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.B.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.D.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.