Geometry

(a) Basic understandings.

(1) Foundation concepts for high school mathematics. As presented in Grades K-8, the basic understandings of number, operation, and quantitative reasoning; patterns, relationships, and algebraic thinking; geometry; measurement; and probability and statistics are essential foundations for all work in high school mathematics. Students continue to build on this foundation as they expand their understanding through other mathematical experiences.

(2) Geometric thinking and spatial reasoning. Spatial reasoning plays a critical role in geometry; geometric figures provide powerful ways to represent mathematical situations and to express generalizations about space and spatial relationships. Students use geometric thinking to understand mathematical concepts and the relationships among them.

(3) Geometric figures and their properties. Geometry consists of the study of geometric figures of zero, one, two, and three dimensions and the relationships among them. Students study properties and relationships having to do with size, shape, location, direction, and orientation of these figures.

(4) The relationship between geometry, other mathematics, and other disciplines. Geometry can be used to model and represent many mathematical and real-world situations. Students perceive the connection between geometry and the real and mathematical worlds and use geometric ideas, relationships, and properties to solve problems.

(5) Tools for geometric thinking. Techniques for working with spatial figures and their properties are essential in understanding underlying relationships. Students use a variety of representations (concrete, pictorial, numerical, symbolic, graphical, and verbal), tools, and technology (including, but not limited to, calculators with graphing capabilities, data collection devices, and computers) to solve meaningful problems by representing and transforming figures and analyzing relationships.

(6) Underlying mathematical processes. Many processes underlie all content areas in mathematics. As they do mathematics, students continually use problem-solving, language and communication, connections within and outside mathematics, and reasoning (justification and proof). Students also use multiple representations, technology, applications and modeling, and numerical fluency in problem solving contexts.

Basic Elements	(G.1) **Geometric structure.** The student understands the structure of, and relationships within, an axiomatic system.	The student is expected to: (A) develop an awareness of the structure of a mathematical system, connecting definitions, postulates, logical reasoning, and theorems; (B) recognize the historical development of geometric systems and know mathematics is developed for a variety of purposes; and (C) compare and contrast the structures and implications of Euclidean and non-Euclidean geometries.
Making Conjectures	(G.2) **Geometric structure.** The student analyzes geometric relationships in order to make and verify conjectures.	The student is expected to: (A) use constructions to explore attributes of geometric figures and to make conjectures about geometric relationships; and (B) make conjectures about angles, lines, polygons, circles, and three-dimensional figures and determine the validity of the conjectures, choosing from a variety of approaches such as coordinate, transformational, or axiomatic.

Axiomatic Systems	(G.3) **Geometric structure.** The student applies logical reasoning to justify and prove mathematical statements.	The student is expected to: (A) determine the validity of a conditional statement, its converse, inverse, and contrapositive; (B) construct and justify statements about geometric figures and their properties; (C) use logical reasoning to prove statements are true and find counter examples to disprove statements that are false; (D) use inductive reasoning to formulate a conjecture; and (E) use deductive reasoning to prove a statement.
Representations	(G.4) **Geometric structure.** The student uses a variety of representations to describe geometric relationships and solve problems.	The student is expected to select an appropriate representation (concrete, pictorial, graphical, verbal, or symbolic) in order to solve problems.
Patterns and Transformations	(G.5) **Geometric patterns.** The student uses a variety of representations to describe geometric relationships and solve problems.	The student is expected to: (A) use numeric and geometric patterns to develop algebraic expressions representing geometric properties; (B) use numeric and geometric patterns to make generalizations about geometric properties, including properties of polygons, ratios in similar figures and solids, and angle relationships in polygons and circles; (C) use properties of transformations and their compositions to make connections between mathematics and the real world, such as tessellations; and (D) identify and apply patterns from right triangles to solve meaningful problems, including special right triangles (45-45-90 and 30-60-90) and triangles whose sides are Pythagorean triples.
Solids: Representations	(G.6) **Dimensionality and the geometry of location.** The student analyzes the relationship between three-dimensional geometric figures and related two-dimensional representations and uses these representations to solve problems.	The student is expected to: (A) describe and draw the intersection of a given plane with various three-dimensional geometric figures; (B) use nets to represent and construct three-dimensional geometric figures; and (C) use orthographic and isometric views of three-dimensional geometric figures to represent and construct three-dimensional geometric figures and solve problems.
Coordinate Geometry	(G.7) **Dimensionality and the geometry of location.** The student understands that coordinate systems provide convenient and efficient ways of representing geometric figures and uses them accordingly.	The student is expected to: (A) use one- and two-dimensional coordinate systems to represent points, lines, rays, line segments, and figures; (B) use slopes and equations of lines to investigate geometric relationships, including parallel lines, perpendicular lines, and special segments of triangles and other polygons; and (C) derive and use formulas involving length, slope, and midpoint.

Area, Surface Area, Volume	(G.8) **Congruence and the geometry of size.** The student uses tools to determine measurements of geometric figures and extends measurement concepts to find perimeter, area, and volume in problem situations.	The student is expected to: (A) find areas of regular polygons, circles, and composite figures; (B) find areas of sectors and arc lengths of circles using proportional reasoning; (C) derive, extend, and use the Pythagorean Theorem; and (D) find surface areas and volumes of prisms, pyramids, spheres, cones, cylinders, and composites of these figures in problem situations.
Properties of Planar and Solid Figures	(G.9) **Congruence and the geometry of size.** The student analyzes properties and describes relationships in geometric figures.	The student is expected to: (A) formulate and test conjectures about the properties of parallel and perpendicular lines based on explorations and concrete models; (B) formulate and test conjectures about the properties and attributes of polygons and their component parts based on explorations and concrete models; (C) formulate and test conjectures about the properties and attributes of circles and the lines that intersect them based on explorations and concrete models; and (D) analyze the characteristics of polyhedra and other three-dimensional figures and their component parts based on explorations and concrete models.
Congruence	(G.10) **Congruence and the geometry of size.** The student applies the concept of congruence to justify properties of figures and solve problems.	The student is expected to: (A) use congruence transformations to make conjectures and justify properties of geometric figures including figures represented on a coordinate plane; and (B) justify and apply triangle congruence relationships.
Proportion and Similarity	(G.11) **Similarity and the geometry of shape.** The student applies the concepts of similarity to justify properties of figures and solve problems.	The student is expected to: (A) use and extend similarity properties and transformations to explore and justify conjectures about geometric figures; (B) use ratios to solve problems involving similar figures; (C) develop, apply, and justify triangle similarity relationships, such as right triangle ratios, trigonometric ratios, and Pythagorean triples using a variety of methods; and (D) describe the effect on perimeter, area, and volume when one or more dimensions of a figure are changed and apply this idea in solving problems.