Geometry - What Your Child Will Learn

Unit 1: Geometric Transformations

In high school, students formalize much of the geometric exploration from middle school. In this unit, students develop rigorous definitions of three familiar congruence transformations: reflections, translations, and rotations and use these transformations to discover and prove geometric properties. Throughout the course, students will use transformations as a tool to analyze and describe relationships between geometric figures.

As students begin to build a geometric system, precise use of language is key. In this unit, the focus of G-CO.A.1 is on definitions not related to a circle. (Definitions related to a circle will be addressed in Unit 8.) Students begin to extend their understanding of rigid transformations to define congruence G-CO.B.6. Dilations will be addressed in Unit 5.) This definition lays the found for work students will do throughout the course around congruence.

Students can use transformation to model the world in which they live, attend to SMP 4, as they consider symmetry in nature. Students should strategically use tools, including tracing paper or dynamic geometry software, to perform transformation SMP 5. As they describe motion, students will need to attend to SMP 6, using precise language. Allowing students to critique non-precise definitions and make them better definitions can help students understand the importance of the language used in writing a precise definition.

Unit 2: Angles and lines

This unit gives students the foundational tools for developing viable geometric arguments using relationships students studied in middle school related to lines, transversals, and special angles associated with them. Students learn how to combine true statements within a mathematical system to deductively prove other statements. Students should begin to see the structure of a mathematical system as they make conjectures and then prove statements involving lines and angles.

Students build on their work with G-CO.A.1 from the previous unit as they solidify their understanding and use of definitions related to angles and lines. These definitions will become core vocabulary and will be used throughout the rest of the course. Precise definitions are important as students begin to formulate proofs about lines and angles as described in G-CO.C.9 (Definitions related to a circle will be addressed in unit 8.)

Students build proficiency with SMP 3 and SMP 7 as they build a mathematical system with structured statements, including postulates and proven theorems. Students should be exposed to a variety of proof styles, including flow-chart proofs, two-column proofs, and paragraph proofs, as they begin to build viable logical arguments. Again, the use of precise language, SMP 6, is critical to building a logical argument.

Unit 3: Triangles

This unit explores basic theorems and conjectures about triangles, including the triangle inequality conjecture, the Triangle Sum Theorem, and theorems regarding centers of a triangle. Students explored some of these relationships in middle school but will build on their work in unit 2 with deductive reasoning and proof related to triangles in this unit. Students make and verify conjectures related to isosceles triangles and explore physical properties of the centroid of a triangle. In this unit, students also learn basic construction techniques and use these as they explore triangle properties. Throughout this unit, students will use precise definitions developed in G-CO.A.1

In this unit, the focus of G-CO.D.13 and G-CO.A.3 should be on triangles, leaving the mid-segments proof G-CO.C.10 until unit 5. At that time, students can apply properties of similar triangles to mid-segments. (Constructions of inscribed squares and regular hexagons and the properties of angles for inscribed quadrilaterals will be addressed in Unit 8.)

As students explore properties of triangles, they will attend to SMP 5, strategically choosing tools such as tracing paper, compass and straightedge, flow charts, and dynamic geometry software for a given situation. As students use the tools to look for patterns, they will make conjectures about properties of triangles. Students gain proficiency in SMP 3 as they continue to write simple proofs using a variety of styles.

Unit 4: Triangle Congruence

This unit builds on students' work with transformations in unit 1 and properties of triangles in unit 3 to formalize the definition of congruent triangles. Students reason to identify criteria for triangle congruence and use precise notation to describe the correspondence in congruent triangles.

In unit 1, students began to use rigid motion transformations to decide if two figures were congruence G-CO.B.6. In this unit, students will return to this idea as they develop shortcuts for proving two triangles are congruent G-CO.B.8.

Students build proficiency with SMP 3 and SMP 7 as they create congruent triangle proofs. Allowing students to critique proofs of other students, whether the work of classmates or fictional student work, will help them develop their own skill in writing proofs. Students continue to build understanding of the structure of a mathematical system and recognize the importance of precise language SMP6.

Unit 5: Similarity Transformations

This unit moves away from rigid motion and focuses on dilations and similarity. Students prove theorems involving similarity and apply dilations and similarity to model situations in the real world.

In this unit, students return to G-CO.C.10 to address mid-segments of triangle, making a connection to G-SRT.B.4, treating mid-segments as a special case of triangle proportionality. Students revisit the Pythagorean Theorem, which they studied in grade 8, but look at a proof based on similarity G-SRT.B.4. The focus is on developing logical arguments to prove a known theorem in a different way. G-GPE.B.6 provides a unique way to think about finding the midpoint of a line segment.

Similarity and proportional reasoning provide powerful tools in representing and solving real-world problems, allowing students to develop proficiency with SMP 1. As students investigate design problems G-MG.A.3, they will often need to model the problem with scaled images. Much of the SMP 1 has to do with understanding how to represent a situation and what mathematical tools can be applied to the situation. In this unit, students continue to build their mathematical system, attend to SMP 8 as they look for patterns in geometric relationships, and then prove their conjectures, attending to SMP 3.

Unit 6: Right Triangle Relationships and Trigonometry

This unit extends the idea of similarity to indirect measurements. Students develop properties of special right triangles, and use properties of similar triangles to develop trigonometric ratios. Students apply these ideas as they model real-world situations and solve problems involving unknown side lengths and angle measures.

In the previous unit, students looked at another proof of the Pythagorean Theorem. In this unit, they continue to solve problems involving right triangles G-SRT.C.8, but can combine the Pythagorean Theorem and trigonometric ratios in their solutions. G-GPE.B.7 presents an opportunity for students to apply the Pythagorean Theorem to develop the distance formula and use the formula to compute area and perimeter.

Although area and perimeter were fully covered in middle school, the standards in this unit give students an opportunity to consolidate old learning and new learning as they solve more complex problems with an array of mathematical tools to choose from. These problem-solving experiences attend to SMP 1 and SMP 4. As students decide how to model situations geometrically and apply properties to the situations, they are attending to SMP 2.

Unit 7: Quadrilaterals

Prior units of this course have focused on triangles. This unit extends that work to the study of quadrilaterals. Students use triangle congruence as they prove theorems about parallelograms. This unit also provides an opportunity for students to become proficient with coordinate proofs.

Many of the properties of special quadrilaterals lend themselves to coordinate proofs, making a nice connections between G-CO.C.11 and G-GPE.B.4. (Coordinate proofs related to circles are addressed in unit 8). Because students have studied and applied the Pythagorean Theorem and the distance formula in previous units, they are ready to use them, along with the midpoint formula and slope relationships from unit 2, to prove theorems about quadrilaterals.

As students become more proficient in geometric reasoning, they begin to consolidate all of their learning to solve problems and prove theorems (SMP 2 and SMP 3). Coordinate proofs are a strategic tool students can use SMP 5.

Unit 8: Circles

This unit explores properties of circles. Students draw on geometric relationships involving lines, angles, triangles and quadrilaterals as they derive the equation of a circle and explore properties of chords, arcs, and angles on circles.

As students explore relationships involving circles, they can return to quadrilaterals to prove an additional property of inscribed quadrilaterals G-C.A.3. They will also use properties of quadrilaterals and triangles, combined with inscribed angles and trigonometry, to construct a square and hexagon inscribed in a circle G-CO.D.13. This unit provides an opportunity to reinforce many concepts addressed earlier in the course as they are applied within circles. G-C.B.5 and G-GMD.A.1 work together to present an opportunity to revisit the concept of area and perimeter in a more complex manner than in middle school. (Volume of a cylinder, pyramid and cone is addressed in unit 10.) G-C.B.5 also extend the idea of arc length to introduce the idea of the radian measure of an angle. The focus in this course should be on proportional relationships, as radian measure can be reinforced in a fourth-year course. Students use coordinates to describe and analyze circles G-GPE.A.1 and G-GPE.B.4.

Circle problems provide an opportunity for complex problem-solving situations that consolidate many different geometric relationships (SMP 2 and SMP 4). In developing the relationships, students will look for patterns, make conjectures, and then construct logical arguments to justify their conjectures.

Unit 9: Geometric Modeling in Two Dimensions

This prior units of this course, students learned about many geometric relationships and developed a mathematical system. This unit provides the opportunity to bring together all of the relationships students have learned in this course and apply them to real-world situations. The unit should present in-depth problems that require students to draw on their understanding of geometric figures and strategically use the tools they have been developing throughout the course.

In this unit, focus the modeling examples on two-dimensional objects only. Unit 10 will bring in three dimensional objects.

The problems presented in this unit should require students to struggle and collaborate, thus building their mathematical persistence SMP 1. Students should see ways to use the geometric relationships they have been learning throughout the course to model real-world situations SMP 4. As students model situations geometrically, they will often have to decontextualize the problem and apply geometric properties SMP 2.

Unit 10: Understanding and Modeling with Three-Dimensional Figures

This unit explores three-dimensional geometry including representations of real-world situations with three-dimensional objects and calculating volume. Students make connections between two-dimensional and three-dimensional representations of objects. Students culminate the course with modeling problems involving three-dimensional objects, allowing them again to integrate their knowledge and apply complex geometric reasoning.

In G-GMD.A.1, focus on three-dimensional objects. Students have worked with the volume formulas in middle school, so the focus here should be on developing arguments for the formulas and applying them to more complex situations.

The problems presented in this unit should require students to struggle and collaborate, thus building their mathematical persistence SMP 1. Students should see ways to use the geometric relationships they have been learning throughout the course to model real-world situations SMP 4. As students model situations geometrically, they will often have to decontextualize the problem and apply geometric properties SMP 2.