Unit 1: Geometric Properties and Theorems

Content Area: **Mathematics**
Course(s): **Geometry Honors 8**
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Transfer

Determines and uses appropriate geometric theorems and properties of rigid motions, lines, angles, triangles and parallelograms to solve **non-routine** problems and prove statements about angle measurement, triangles, distance, line properties and congruence.

- Try to have the students accomplish the constructions in a variety of ways- using compass and straightedge (which seems to be the main focus of PARCC, geometry software (like Geogebra), and patty paper. Make connections between the mediums- how do you create congruence using patty paper vs. compass?
- The main focus behind the constructions is "Why do they work?", not "How do I do them?"
- The advanced constructions (inscribed polygons) and triangle centers (incenter, orthocenter) are a good capstone to this unit. Students can implement their basic construction skills to figure out how to create the advanced constructions, and then explain the properties of the triangle centers using geometric concepts.
- Use a variety of mediums for transformations: tracing paper, graph paper, geometry software.
- Allow students to explore transformation properties, such as corresponding congruent parts given different transformations.
- Provide students with a pre-image and an image and have them figure out different ways to map one onto the other.
- Transformations should be defined in terms of parallel lines.
- Rotations move along a circular arc given a specified angle.
- Reflections are drawn using perpendicular bisectors over the mirror line.
- (+) = denotes Honors only skill not on PARCC Assessments

Essential Questions

What is the importance of circles when creating constructions?

Why is constructing figures preferred over a sketch?

How can you change a figure without changing its shape?

What are different ways to represent transformations?

Enduring Understandings

Circles are a collection of points equidistant from a given point- using this equidistance can help you create congruent figures.

Using a compass and straightedge to construct a figure is more accurate than a sketch because it does not rely on measurements, which are inherently estimates.

Isometries are transformations that preserve length and distance, while dilations change lengths and preserve angle measure.

Transformations can be represented on the coordinate plane by plotting points, off the coordinate plane using constructions, and as function mapping diagram

Standards in Mathematics

The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students.

The Standards for Mathematical Practice describe ways in which developing student practitioners of the discipline of mathematics increasingly ought to engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle and high school years. Designers of curricula, assessments, and professional development should all attend to the need to connect the mathematical practices to mathematical content in mathematics instruction.

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

MA.8.NS.A	Know that there are numbers that are not rational, and approximate them by rational numbers.
MA.G-CO.A	Experiment with transformations in the plane
MA.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.
MA.8.NS.A.1	Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion which repeats eventually into a rational number.
MA.8.NS.A.2	Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., π^2).
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
	Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.
MA.K-12.4	Model with mathematics.
	Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.
MA.K-12.5	Use appropriate tools strategically.
	Mathematically proficient students consider the available tools when solving a

	mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.
MA.K-12.6	Attend to precision.
	Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.
MA.G-CO.D	Make geometric constructions
MA.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.).
MA.G-CO.D.13	Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.
MA.7.G.A	Draw, construct, and describe geometrical figures and describe the relationships between them.
MA.7.G.A.2	Draw (with technology, with ruler and protractor, as well as freehand) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.
MA.7.G.A.3	Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.
MA.G-GPE.B	Use coordinates to prove simple geometric theorems algebraically
MA.G-GPE.B.4	Use coordinates to prove simple geometric theorems algebraically.
MA.G-GPE.B.6	Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
MA.G-GPE.B.7	Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

Critical Knowledge and Skills

Vocabulary

Definitions, Notation, and Diagrams

Basic constructions

Advanced Constructions

Basic transformation definition

Properties of basic transformations

Symmetry

Compositions of transformations

Mapping Congruent Figures

Learning Objectives

Define applicable geometric terms using precise words, diagrams and correct notation.

Explain what the undefined terms are and why they are undefined.

Use geometric concepts to explain the reasoning for the steps/procedures used in performing a constructions.

Use a compass and straightedge to create the following constructions:

- copy a given line segment.
- copy a given angle.
- bisect a line segment.
- bisect an angle.
- construct a line perpendicular to a given line through a point on that line.
- construct a line perpendicular to a given line through a point not on that line.
- construct the perpendicular bisector of a line segment.
- construct a line parallel to a given line through a point not on the line.
- an equilateral triangle
- a square
- a regular hexagon inscribed in a circle
- a line tangent to a circle (+)

Use constructions to solve basic application problems

Use constructions to solve advanced application problems (+)

Define reflections, rotations, and translations in terms of angles, circles, perpendicular line, parallel line, and line segment

Reflect, rotate, and translate figures in the coordinate plane, including compositions

Describe transformations as functions that take inputs and give other points as outputs

Identify an isometric transformation by describing whether the image and pre image have congruent lengths and angles

Construct the image of a figure given the figures and its transformation NOT on the coordinate plane (+)

Describe reflectional, rotational, and point symmetry using reflections and rotations, with a focus on rectangle, parallelogram, trapezoid, and regular polygons

Given a pre image and image, describe transformations that will map one figure onto another

Prove two figures are congruent if there is a sequence of rigid motions that map one figure to another.

Prove that two figures are congruent if and only if they have the same shape and size.

Use composite transformations to map on figure onto another.

Explain the effects of rigid motion on orientation and location of a figure.

Use the definition of congruence in terms of transformations as a test to see if two figures are congruent.

Resources

Pearson Resources:

1-2, 1-3, 1-4, 1-6, 3-1, CB 3-2, 3-6, 4-4, CB 4-5, 4-5 5-2, CB 6-9, CB 7-5, 10-3, 10-6, all of Ch. 9

Online Resources:

Dividing a town into Pizza delivery regions: http://illuminations.nctm.org/Lesson.aspx?id=2688

Security Cameras: http://illuminations.nctm.org/Lesson.aspx?id=2788

Placing a Fire Hydrant: https://www.illustrativemathematics.org/illustrations/508

Pop-Up Box design: http://mrpiccmath.weebly.com/blog/3-acts-pop-box-design

Transversals, Tape, and Stickies: http://mr-stadel.blogspot.com/2012/10/transversals-tape-and-stickies.html

Best Midpoint: http://threeacts.mrmeyer.com/bestmidpoint/

https://www.illustrativemathematics.org/HSG-CO.A

G.CO.A.1: http://www.shmoop.com/common-core-standards/ccss-hs-g-co-1.html

G.CO.D.12: http://www.shmoop.com/common-core-standards/ccss-hs-g-co-12.html

G.CO.D.13: http://www.shmoop.com/common-core-standards/ccss-hs-g-co-13.html

Construction directions:

http://www.mathsisfun.com/geometry/constructions.html

http://www.mathopenref.com/constructions.html

http://www.onlinemathlearning.com/geometry-construction.html

Transformations:

http://www.shmoop.com/common-core-standards/math-geometry-congruence.html

http://jdevarona.wordpress.com/2012/07/13/let-the-random-problem-ideas-begin/

- https://www.illustrativemathematics.org/illustrations/1545
- https://www.illustrativemathematics.org/illustrations/1546
- http://emergentmath.com/2012/01/07/can-we-make-an-even-edgier-brownie-pan-what-about-the-perfect-brownie-pan/
- http://illuminations.nctm.org/Lesson.aspx?id=2626
- http://illuminations.nctm.org/Lesson.aspx?id=1540
- http://illuminations.nctm.org/Lesson.aspx?id=3141