Standard 4 : Make geometric constructions. (Geometry - Supporting Cluster)

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Clusters should not be sorted from Major to Supporting and then taught in that order. To do so would strip the coherence of the mathematical ideas and miss the opportunity to enhance the major work of the grade with the supporting clusters.

Number: MAFS.912.G-CO.4	**Title:** Make geometric constructions. (Geometry - Supporting Cluster)
Type: Cluster	**Subject:** Mathematics
Grade: 912	**Domain-Subdomain:** Geometry: Congruence

Related Standards

Code	Description
MAFS.912.G-CO.4.12	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. **Remarks/Examples:** **Geometry - Fluency Recommendations** 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.
MAFS.912.G-CO.4.13	Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Related Access Points

Access Point

Access Point Number	Access Point Title
MAFS.912.G-CO.4.AP.12a:	Copy a segment.
MAFS.912.G-CO.4.AP.12b:	Copy an angle.
MAFS.912.G-CO.4.AP.12c:	Bisect a segment.
MAFS.912.G-CO.4.AP.12d:	Bisect an angle.
MAFS.912.G-CO.4.AP.12e:	Construct perpendicular lines, including the perpendicular bisector of a line segment.
MAFS.912.G-CO.4.AP.12f:	Construct a line parallel to a given line through a point not on the line.
MAFS.912.G-CO.4.AP.13a:	Construct an equilateral triangle, a square and a regular hexagon inscribed in a circle.

Related Resources

Original Student Tutorial

Name	Description
A Square Peg in a Round Hole:	Learn how to construct an inscribed square in a circle and why certain constructions are used in this interactive tutorial.
Angle UP: Player 1:	Explore the construction processes for constructing an angle bisector, copying an angle and constructing a line parallel to a given line through a point not on the line using a variety of tools in this interactive, retro video game-themed tutorial.
Designing with Hexagons:	Learn how to construct an inscribed regular hexagon and equilateral triangle in a circle in this interactive tutorial.
Meet Me Half Way:	Plan a paddle board expedition by learning how to do basic geometric constructions including copying a segment, constructing a segment bisector, constructing a segment's perpendicular bisector and constructing perpendicular segments using a variety of tools in this interactive tutorial.

Name	Description
The Blueprints of Construction:	Learn to construct the perpendicular bisector of a line segment using a straightedge and compass with this interactive tutorial.

Problem-Solving Task

Name	Description
Angle bisection and midpoints of line segments:	This task provides a construction of the angle bisector of an angle by reducing it to the bisection of an angle to finding the midpoint of a line segment. It is worth observing the symmetry -- for both finding midpoints and bisecting angles, the goal is to cut an object into two equal parts.
Bisecting an angle:	This problem solving task challenges students to bisect a given angle.
Construction of perpendicular bisector:	This problem solving task challenges students to construct a perpendicular bisector of a given segment.
Inscribing a hexagon in a circle:	This problem solving task challenges students to inscribe equilateral triangles and regular hexagons on a circle with a compass and straightedge.
Inscribing a square in a circle:	This task provides an opportunity for students to apply triangle congruence theorems in an explicit, interesting context.
Locating Warehouse:	This problem solving task challenges students to place a warehouse (point) an equal distance from three roads (lines).
Reflected Triangles:	This task asks students to use a straightedge and compass to construct the line across which a triangle is reflected.

Lesson Plan

Name	Description
Back to the Basics: Constructions:	Students will use compass and straightedge to develop methods for constructions.
Bisecting Angles And Line Segments:	This construction lesson will teach students how to bisect an angle and how to find the perpendicular bisector of a segment using a compass and straightedge.
Circumnavigating The Circumcenter:	Students use the concurrent point of perpendicular bisectors of triangle sides to determine the circumcenter of three points. Students will reason that the circumcenter of the vertices of a polygon is the optimal location for placement of a facility to service all of the needs of sites at the vertices forming the polygon.
Construct Regular Polygons Inside Circles :	Students will be able to demonstrate that they can construct, using the central angle method, an equilateral triangle, a square, and a regular hexagon, inscribed inside a circle, using a compass, straightedge, and protractor. They will use worksheets to master the construction of each polygon, one inside each of three different circles. As an extension to this lesson, if computers with GeoGebra are available, the students should be able to perform these constructions on computers as well.
Construct This:	In this lesson, students will construct a square inscribed in a circle using the properties of a square and determine if there is more than one way to complete the construction.
Constructing an Angle Bisector:	Students construct an angle bisector given a straightedge and compass then verify their process. The Guided Practice is done in stations. One that is teacher lead and one that is student lead. In order to complete the student lead Guided Practice, access to a teacher computer and projector is needed. Then the students independently create their own angle and its bisector and verify their work for a grade. Students use patty paper and protractors to confirm the accuracy of the construction.
Construction Junction:	Students will learn how to construct an equilateral triangle and a regular hexagon inscribed in a circle using a compass and a straightedge.
Construction of Inscribed Regular Hexagon:	A GeoGebra lesson for students to become familiar with computer based construction tools. Students work together to construct a regular hexagon inscribed in a circle using rotations. Both a beginner and advanced approach are available.
Copying and Bisecting an Angle:	This lesson is a gradual release model that takes students through the process of constructing congruent angles and bisecting angles.
Crafty Circumference Challenge:	Students identify, find, and use recycled, repurposed, or reclaimed objects to create "crafty" construction tools to partition the circumference of a circle into three, four, and six congruent arcs which determine vertices of regular polygons inscribed in the circle.
Detemination of the Optimal Point:	Students will use dynamic geometry software to determine the optimal location for a facility under a variety of scenarios. The experiments will suggest a relation between the optimal point and a common concept in geometry; in some cases, there will be a connection to a statistical concept. Algebra can be used to verify some of the conjectures.
Determination of the Optimal Point (formerly where to build a house):	Students will use dynamic geometry software to determine the optimal location for a facility under a variety of scenarios. The experiments will suggest a relation between the optimal point and a common concept in geometry; in some cases, there will be a connection to a statistical concept. Algebra can be used to verify some of the conjectures.
Engineering Design Challenge: Exploring Structures in High School Geometry :	Students explore ideas on how civil engineers use triangles when constructing bridges. Students will apply knowledge of congruent triangles to build and test their own bridges for stability.
Geometric Construction Site:	This lesson takes students from simple construction of line segments and angles to an optional extension worksheet for creating triangles.

Halfway to the Middle!:	Students will develop their knowledge of mid-segments of a triangle, construct and provide lengths of mid-segments.
Inscribe it:	This activity allows students to practice the construction process inscribing a regular hexagon and an equilateral triangle in a circle using GeoGebra software.
Inscribe Those Rims:	This lesson will engage students with an interactive and interesting way to learn how to inscribe polygons in circles.
Location, Location, Location, Location?:	Students will use their knowledge of graphing concurrent segments in triangles to locate and identify which points of concurrency are associated by location with cities and counties within the Texas Triangle Mega-region.
Paper Plate Origami:	This lesson highlights a hands-on activity where students construct inscribed regular polygons in a circle using models. Through guided questions, students will discover how to divide a model (paper plate) into 3, 4 and 6 parts. Using folding, a straightedge and compass, they will construct an equilateral triangle, a square and a regular hexagon in their circles.
Patterns in Fractals:	This lesson is designed to introduce students to the idea of finding patterns in the generation of several different types of fractals. This lesson provides links to discussions and activities related to patterns and fractals as well as suggested ways to work them into the lesson. Finally, the lesson provides links to follow-up lessons designed for use in succession with the current one.
Right turn, Clyde!:	Students will develop their knowledge of perpendicular bisectors & point of concurrency of a triangle, as well as construct perpendicular biesctors through real world problem solving with a map.
St. Pi Day construction with a compass & ruler:	St. Pi Day construction with compass This activity uses a compass and straight-edge(ruler) to construct a design. The design is then used to complete a worksheet involving perimeter, circumference, area and dimensional changes which affect the scale factor ratio.
Triangle Medians:	This lesson will have students exploring different types of triangles and their medians. Students will construct mid-points and medians to determine that the medians meet at a point.
What's the Point? Part 1:	This is a patty paper-folding activity where students measure and discover the properties of the point of concurrency of the perpendicular bisectors of the sides of a triangle.
What's the Point? Part 2:	In this lesson, students use a paper-folding technique to discover the properties of angle bisectors. At the conclusion of the activity, students will be able to compare/contrast the points of concurrency of perpendicular and angle bisectors.

Formative Assessment

Name	Description
Bisecting a Segment and an Angle :	Students are asked to construct the bisectors of a given segment and a given angle and to justify one of the steps in each construction.
Construct the Center of a Circle:	Students are asked to construct the center of a circle.
Constructing a Congruent Angle:	Students are asked to construct an angle congruent to a given angle.
Constructing a Congruent Segment:	Students are asked to construct a line segment congruent to a given line segment.
Constructions for Parallel Lines:	Students are asked to construct a line parallel to a given line through a given point.
Constructions for Perpendicular Lines:	Students are asked to construct a line perpendicular to given line (1) through a point not on the line and (2) through a point on the line.
Equilateral Triangle in a Circle:	Students are asked to construct an equilateral triangle inscribed in a circle.
Regular Hexagon in a Circle:	Students are asked to construct a regular hexagon inscribed in a circle.
Square in a Circle:	Students are asked to construct a square inscribed in a circle.

Educational Game

Name	Description
Construct Bisectors and Other Lines:	Play a game to construct perpendicular lines, perpendicular bisectors, midpoints and angle bisectors. Students may select **Teach Me** to learn about constructions prior to beginning play. Hints and feedback are provided to players.

Tutorial

Name	Description
Constructing Polygons Inscribed in Circles:	**Click "View Site" to open a full-screen version.** Geometric constructions using tools such as a compass and straightedge can help students better understand geometric concepts and the underlying principles that govern their relationships. The focus in this tutorial is on the construction of an equilateral triangle, square, and regular hexagon inscribed in a circle.

Virtual Manipulative

Name	Description
Inscribe a Regular Hexagon in a Circle:	This geogebratube interactive worksheet shows the step by step process for inscribing a regular hexagon in a circle. There are other geogebratube interactive worksheets for the square and the equilateral triangle.

Video/Audio/Animation

Name	Description
MIT BLOSSOMS - Using Geometry to Design Simple Machines:	This video is meant to be a fun, hands-on session that gets students to think hard about how machines work. It teaches them the connection between the geometry that they study and the kinematics that engineers use -- explaining that kinematics is simply geometry in motion.

Assessment

Name	Description
Sample 1 - High School Geometry State Interim Assessment:	This is a State Interim Assessment for 9th-12th grade.
Sample 2 - High School Geometry State Interim Assessment:	This is a State Interim Assessment for 9th-12th grade.
Sample 3 - High School Geometry State Interim Assessment:	This is a State Interim Assessment for 9th-12th grade.
Sample 4 - High School Geometry State Interim Assessment:	This is a State Interim Assessment for 9th-12th grades.

Unit/Lesson Sequence

Name	Description
Three Dimensional Shapes:	In this interactive, self-guided unit on 3-dimensional shape, students (and teachers) explore 3-dimensional shapes, determine surface area and volume, derive Euler's formula, and investigate Platonic solids. Interactive quizzes and animations are included throughout, including a 15 question quiz for student completion.

Student Resources

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Construct Bisectors and Other Lines:	Play a game to construct perpendicular lines, perpendicular bisectors, midpoints and angle bisectors. Students may select **Teach Me** to learn about constructions prior to beginning play. Hints and feedback are provided to players.
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Designing with Hexagons:	Learn how to construct an inscribed regular hexagon and equilateral triangle in a circle in this interactive tutorial.
Inscribe a Regular Hexagon in a Circle:	This geogebratube interactive worksheet shows the step by step process for inscribing a regular hexagon in a circle. There are other geogebratube interactive worksheets for the square and the equilateral triangle.
Inscribing a hexagon in a circle:	This problem solving task challenges students to inscribe equilateral triangles and regular hexagons on a circle with a compass and straightedge.
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Meet Me Half Way:	Plan a paddle board expedition by learning how to do basic geometric constructions including copying a segment, constructing a segment bisector, constructing a segment's perpendicular bisector and constructing perpendicular segments using a variety of tools in this interactive tutorial.
Reflected Triangles:	This task asks students to use a straightedge and compass to construct the line across which a triangle is reflected.
The Blueprints of Construction:	Learn to construct the perpendicular bisector of a line segment using a straightedge and compass with this interactive tutorial.

Parent Resources

Title	Description

[Angle bisection and midpoints of line segments:](#)	This task provides a construction of the angle bisector of an angle by reducing it to the bisection of an angle to finding the midpoint of a line segment. It is worth observing the symmetry -- for both finding midpoints and bisecting angles, the goal is to cut an object into two equal parts.
[Bisecting an angle:](#)	This problem solving task challenges students to bisect a given angle.
[Construction of perpendicular bisector:](#)	This problem solving task challenges students to construct a perpendicular bisector of a given segment.
[Inscribing a hexagon in a circle:](#)	This problem solving task challenges students to inscribe equilateral triangles and regular hexagons on a circle with a compass and straightedge.
[Inscribing a square in a circle:](#)	This task provides an opportunity for students to apply triangle congruence theorems in an explicit, interesting context.
[Locating Warehouse:](#)	This problem solving task challenges students to place a warehouse (point) an equal distance from three roads (lines).
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