

Geometry Year at a Glance

Name of Unit	Learning Goals	Knowledge & Skills
• Unit 1: Congruence, Proofs, and Constructions (45 days)	•	•
• Unit 2: Similarity, Proof, and Trigonometry	•	
• Unit 3: Extending to Three Dimensions (10 days)	•	•
• Unit 4: Connecting Algebra and Geometry through Coordinates (25 days)	•	•
• Unit 5: Circles with and Without Coordinates (25 days)	•	•

Unit 1: Congruence, Proofs, and Constructions

Unit overview: (Narrative description of unit purpose)

In previous grades, students were asked to draw triangles based on given measurements. They also have prior experience with rigid motions—translations, reflections, and rotations—and have strategically applied a rigid motion to informally show that two triangles are congruent. In this unit, students establish triangle congruence criteria, based on analyses of rigid motions and formal constructions. They build upon this familiar foundation of triangle congruence to develop formal proof techniques. Students make conjectures and construct viable arguments to prove theorems—using a variety of formats—and solve problems about triangles, quadrilaterals, and other polygons. They construct figures by manipulating appropriate geometric tools (compass, ruler, protractor, etc.) and justify why their written instructions produce the desired figure.

Learning Goals:

The student will be able to:

- Experiment with transformations in the plane
- Recognize and apply definitions and theorems of angles and lines
- Understand congruence in terms of rigid motions
- Prove geometric theorems regarding lines and angles, triangles, and quadrilaterals
- Make geometric constructions

Instructional Strategies and Structures:

- Use Geometric Software and tools to construct and manipulate figures
- Through inference, discover connections for geometric theorems
- Small group and whole class collaboration

Time Span: (Length of Unit) 45 days

Assessment: (Methods used for formative and summative)

- Homework
- Exit Slips
- Student Response Devices
- Quizzes and Tests
- Common Semester Tests

Vocabulary and Key Concepts

Properties of Lines	Transversal	Bisect
Translations	Rotations	Reflections
Glide Reflection	Congruence	Vertical Angles
Same Side Interior Angles	Alternate Interior Angles	Alternate Exterior Angles
Linear Pair	Corresponding Angles	Side-Side-Side Triangle Congruence Theorem
Side-Angle-Side Triangle Congruence Theorem	Angle-Side-Angle Triangle Congruence Theorem	Angle-Angle-Side Triangle Congruence Theorem
Hypotenuse-Leg Triangle Congruence Theorem	Sufficient Conditions for Quadrilaterals	Properties of Quadrilaterals

Unit 1:

Common Core State Standards or Michigan Content Expectations

Experiment with transformations in the plane

G-CO.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.

G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

Understand congruence in terms of rigid motions

G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

Prove geometric theorems

G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when

a transversal crosses parallel lines, alternate interior angles are congruent and corresponding

angles are congruent; points on a perpendicular bisector of a line segment are exactly those

equidistant from the segment's endpoints.

G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180° ; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

Make geometric constructions

G-CO.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.

G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Unit 2: Similarity, Proof, and Trigonometry

Unit overview: (Narrative description of unit purpose)

Students apply their earlier experience with dilations and proportional reasoning to build a formal understanding of similarity. They identify criteria for similarity of triangles, make sense of and persevere in solving similarity problems, and apply similarity to right triangles to prove the Pythagorean Theorem. Students attend to precision in showing that trigonometric ratios are well defined, and apply trigonometric ratios to find missing measures of general (not necessarily right) triangles. Students model and make sense out of indirect measurement problems and geometry problems that involve ratios or rates.

Learning Goals:

The student will be able to:

- Understand similarity in terms of similarity transformations
- Prove theorems involving similarity
- Define trigonometric ratios and solve problems involving right triangles
- Apply geometric concepts in modeling situations

Instructional Strategies and Structures:

- Use Geometric Software and tools to construct and manipulate figures
- Through inference, discover connections for geometric theorems
- Small group and whole class collaboration
- Problem Solving in real-world context using similar triangles

Time Span: (Length of Unit) 45 days

Assessment: (Methods used for formative and summative)

- Homework
- Exit Slips
- Student Response Devices
- Quizzes and Tests
- Common Semester Tests

Vocabulary and Key Concepts

Scale Factor	Angle-Angle Triangle	Trigonometric
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	Similarity	Ratios
Sine	Cosine	Tangent
Dilation	Proportional	Geometric Mean
Side-Side-Side Triangle Similarity	Side-Angle-Side Triangle Similarity	

Unit 2:

Common Core State Standards or Michigan Content Expectations

Understand similarity in terms of similarity transformations

G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor:

- A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.
- The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Prove theorems involving similarity

G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Define trigonometric ratios and solve problems involving right triangles

G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles.

G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right

triangles in applied problems.

Apply geometric concepts in modeling situations

G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

G-MG.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with topographic grid systems based on ratios).

Unit 3: Extending to Three Dimensions

Unit overview: (Narrative description of unit purpose)

Students' experience with two-dimensional and three-dimensional objects is extended to include informal explanations of circumference, area and volume formulas. Additionally, students apply their knowledge of two-dimensional shapes to consider the shapes of cross-sections and the result of rotating a two-dimensional object about a line. They reason abstractly and quantitatively to model problems using volume formulas.

Learning Goals:

The student will be able to:

- Explain volume and surface area formulas and use them to solve problems
- Visualize relationships between two-dimensional and three-dimensional objects
- Apply geometric concepts in modeling situations

Instructional Strategies and Structures:

- Use Geometric Software and tools to construct and manipulate figures
- Through inference, discover connections for geometric theorems
- Small group and whole class collaboration
- Problem Solving in real-world context using three-dimensional figures

Time Span: (Length of Unit)

20 Days

Assessment: (Methods used for formative and summative)

- Homework
- Exit Slips
- Student Response Devices
- Quizzes and Tests
- Common Semester Tests

Vocabulary and Key Concepts

Volume	Surface Area	Lateral Area
Cross section		

Unit 3:

Common Core State Standards or Michigan Content Expectations

Explain volume formulas and use them to solve problems

G-GMD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

G-GMD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

Visualize relationships between two-dimensional and three-dimensional objects

G-GMD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Apply geometric concepts in modeling situations

G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

Unit 4: Connecting Algebra and Geometry through Coordinates

Unit overview: (Narrative description of unit purpose)

Building on their work with the Pythagorean theorem in 8th grade to find distances, students analyze geometric relationships in the context of a rectangular coordinate system, including properties of special triangles and quadrilaterals and slopes of parallel and perpendicular lines, relating back to work done in the first unit. They solve design problems by representing figures in the coordinate plane, and in doing so, they leverage their knowledge from synthetic geometry by combining it with the solving power of algebra inherent in analytic geometry.

Learning Goals:

The student will be able to:

- Use coordinates to prove geometric theorems algebraically

Instructional Strategies and Structures:

- Use Geometric Software and tools to construct and manipulate figures
- Through inference, discover connections for geometric theorems
- Small group and whole class collaboration

Time Span: (Length of Unit) 25 Days

Assessment: (Methods used for formative and summative)

- Homework
- Exit Slips
- Student Response Devices
- Quizzes and Tests
- Common Semester Tests

Vocabulary and Key Concepts

Slope	Parallel Lines	Perpendicular Lines
Distance Formula	Midpoint Formula	Pythagorean Theorem

Unit 4:

Common Core State Standards or Michigan Content Expectations

Use coordinates to prove simple geometric theorems algebraically

G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point $(0, 2)$.

G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

Unit 5: Circles with and Without Coordinates (25 days)

Unit overview: (Narrative description of unit purpose)

In this unit students prove and apply basic theorems about circles, such as: a tangent line is perpendicular to a radius theorem, the inscribed angle theorem,

and theorems about chords, secants, and tangents dealing with segment lengths and angle measures. They study relationships among segments on chords, secants, and tangents as an application of similarity. In the Cartesian coordinate system, students explain the correspondence between the definition of a circle and the equation of a circle written in terms of the distance formula, its radius, and coordinates of its center. Given an equation of a circle, they draw the graph in the coordinate plane, and apply techniques for solving quadratic equations.

Learning Goals:

The student will be able to:

- Understand and apply theorems of circles
- Find arc lengths and areas of sectors of circles
- Derive the equation for a circle on the coordinate plane
- Apply geometric concepts in modeling situations

Instructional Strategies and Structures:

- Use Geometric Software and tools to construct and manipulate figures
- Through inference, discover connections for geometric theorems
- Small group and whole class collaboration
- Problem Solving in real-world context using circles

Time Span: (Length of Unit) 25 Days

Assessment: (Methods used for formative and summative)

- Homework
- Exit Slips
- Student Response Devices
- Quizzes and Tests
- Common Semester Tests

Vocabulary and Key Concepts

Circle	Radius	Diameter
Arc	Central Angle	Inscribed Angle
Chord	Tangent	Secant
Equation of a Circle		

Unit 5:

Common Core State Standards or Michigan Content Expectations

Understand and apply theorems about circles

G-C.1 Prove that all circles are similar.

G-C.2 Identify and describe relationships among inscribed angles, radii, and chords.

Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.
G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

Find arc lengths and areas of sectors of circles

G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector

Translate between the geometric description and the equation for a conic section

G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

Use coordinates to prove simple geometric theorems algebraically

G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point $(0, 2)$.

Apply geometric concepts in modeling situations

G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).