

New Jersey Student Learning Standards for Mathematics and Student Learning Objectives

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Geometry – Geometric Constructions and Congruence – Unit 1

Rationale

In earlier grades, learners measured angle, identified parallel and perpendicular lines in figures, and worked with triangles in a variety of ways to understand various mathematical concepts. In this unit, learners deepen their understanding of these concepts by performing constructions using a variety of tools and technologies. First, they learn the precise definitions of angle, circle, perpendicular line, parallel line, and line segment. They build on their grade 8 work with transformations to explore transformations in terms of rigid motions, representing transformations in the plane and describing transformations as functions. Throughout this unit, learners explore and utilize proof to deepen and apply their understanding of congruence. They prove theorems about lines, angles, triangles, and parallelograms; and use the definition of congruence in terms of rigid motions to show that two triangles are congruent.

Geometry – Unit 1, Module A

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
 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.	▪ define line segment based on some or all of the undefined notions of point, line, distance along a line, and distance around a circular arc ▪ define angle based on some or all of the undefined notions of point, line, distance along a line, and distance around a circular arc ▪ define parallel lines based on some or all of the undefined notions of point, line, distance along a line, and distance around a circular arc ▪ define perpendicular lines based on some or all of the undefined notions of point, line, distance along a line, and distance around a circular arc

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Standard	Student Learning Objectives We are learning to ... / We are learning that ...
▣ 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.). <i>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.</i>	▪ compass, straightedge, string, reflective devices, and dynamic geometric software are examples of tools that may be used to make formal geometric constructions ▪ make formal geometric constructions with a variety of tools and methods (i.e. paper folding) ▪ use a variety of geometric tools and methods to copy a segment ▪ use a variety of geometric tools and methods to copy an angle ▪ use a variety of geometric tools and methods to bisect a segment ▪ use a variety of geometric tools and methods to bisect an angle ▪ use a variety of geometric tools and methods to construct perpendicular lines, including perpendicular bisectors ▪ use a variety of geometric tools and methods to construct a line parallel to a given line through a point not on the line
▣ G.CO.D.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.	▪ construct an equilateral triangle inscribed in a circle ▪ construct a regular hexagon inscribed in a circle ▪ construct a square inscribed in a circle

New Jersey Student Learning Standards for Mathematics and Student Learning Objectives

Geometry – Unit 1, Module B

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
▣ G.CO.A.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).	▪ represent transformations in the plane using 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
▣ G.CO.A.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself. ▣ G.CO.A.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments. ▣ G.CO.A.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.	▪ describe rotations that carry a given rectangle, parallelogram, trapezoid, or regular polygon onto itself ▪ develop the definition of rotations in terms of angles, circles, perpendicular lines, parallel lines, and/or line segments ▪ given a figure and a rotation, draw the transformed figure using graph paper, tracing paper, or geometry software ▪ describe reflections that carry a given rectangle, parallelogram, trapezoid, or regular polygon onto itself ▪ develop the definition of reflections in terms of angles, circles, perpendicular lines, parallel lines, and/or line segments ▪ given a figure and a reflection, draw the transformed figure using graph paper, tracing paper, or geometry software ▪ develop the definition of translations in terms of angles, circles, perpendicular lines, parallel lines, and/or line segments ▪ develop the definition of translation in terms of angles, circles, perpendicular lines, parallel lines, and/or line segments ▪ specify a sequence of transformations that will carry a given figure onto another
■ G.CO.B.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.	▪ use geometric descriptions of rigid motions to transform figures. ▪ predict the effect of a given rigid motion on a given figure using geometric descriptions of rigid motions ▪ use the definition of congruence in terms of rigid motions to decide if two given figures are congruent

New Jersey Student Learning Standards for Mathematics and Student Learning Objectives

Geometry – Unit 1, Module C

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
■ G.CO.C.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.C.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.	■ prove theorems about lines and angles ■ prove vertical angles are congruent ■ prove that when a transversal crosses parallel lines, alternate interior angles are congruent ■ prove that when a transversal crosses parallel lines, corresponding angles are congruent ■ prove measures of the interior angles of a triangle sum to 180 degrees.
■ G.CO.B.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.	■ show that two triangles are congruent using the definition of congruence in terms of rigid motions if and only if corresponding pairs of sides and corresponding pairs of angles are congruent
■ G.CO.B.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.	■ explain how ASA, SAS, and SSS follow from the definition of congruence in terms of rigid motions.

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■ G.CO.C.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.C.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.	▪ prove points on a perpendicular bisector of a line segment are exactly those that are equidistant from the segment endpoints ▪ prove theorems about triangles ▪ prove base angles of an isosceles triangle are congruent ▪ prove that the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length ▪ prove the medians of a triangle meet at a point

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Geometry – Unit 1, Module D

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
 G.CO.C.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.	▪ prove theorems about parallelograms ▪ prove opposite sides in a parallelogram are congruent ▪ prove opposite angles in a parallelogram are congruent ▪ prove the diagonals of a parallelogram bisect each other ▪ prove rectangles are parallelograms with congruent diagonals

New Jersey Student Learning Standards for Mathematics and Student Learning Objectives

Geometry – Similarity and Dilations – Unit 2

Rationale

In grade 7, learners represented and solved real world and mathematical problems using proportions. They studied angle measures and their relationships within geometric figures. Building on these ideas, learners solve problems involving similar geometric figures. They 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, and use properties of similarity transformations to establish Angle-Angle criterion. This unit concludes as learners, building on earlier work with the Pythagorean Theorem, to apply proportions as they use trigonometric ratios and the Pythagorean Theorem to solve right triangles.

Geometry – Unit 2, Module A

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
■ G.SRT.A.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.CO.A.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).	- verify experimentally, given a center and scale factor, that the dilation of a line segment is longer or shorter in the ratio given by the scale factor - verify experimentally, given a center and scale factor, that a dilation leaves a line passing through the center of the dilation unchanged - verify experimentally, given a center and scale factor, that a dilation takes a line not passing through the center of the dilation to a parallel line - represent dilations in the plane using transparencies and geometry software - compare transformations, including dilations, that preserve distance and angle to those that do not

New Jersey Student Learning Standards for Mathematics and Student Learning Objectives

Geometry – Unit 2, Module B

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
■ G.SRT.A.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.	▪ use the definition of similarity in terms of similarity transformations to decide if two figures are similar ▪ use similarity transformations to explain 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.A.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.	▪ use the properties of similarity transformations to establish the conditions for triangle similarity through the AA criterion
■ G.SRT.B.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.	▪ prove that a line parallel to one side of a triangle divides the other two sides of the triangle proportionally ▪ prove that a line that divides two sides of a triangle proportionally is parallel to the third side ▪ prove, using triangle similarity, the Pythagorean Theorem
■ G.SRT.B.5 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.	▪ use the definition of similarity in terms of similarity transformations to decide if two given figures 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

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Geometry – Unit 2, Module C

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
G.SRT.C.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.	▪ similarity in right triangles leads to proportional relationships which produce the trigonometric ratios for the acute angles in the right triangle ▪ side ratios in right triangles are properties of the angles in the triangle as a result of properties of triangle similarity ▪ define trigonometric ratios for acute angles
G.SRT.C.7 Explain and use the relationship between the sine and cosine of complementary angles.	▪ explain and use the relationship between the sine and cosine of complementary angles
G.SRT.C.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.★	▪ use trigonometric ratios to solve right triangles in applied problems ▪ use Pythagorean Theorem to solve right triangles in applied problems

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Geometry – Geometric Properties and Equations – Unit 3

Rationale

In this unit, learners apply the concepts of congruence and similarity to prove simple theorems algebraically using coordinates. They prove slope criteria and use them to solve geometric problems. Learners compute perimeters of polygons and areas of triangles and rectangles using coordinates. This unit concludes as learners, knowing the precise definition of a circle, derive the equation of a circle using the Pythagorean Theorem and use algebra techniques to find the center and radius of a circle given by an equation.

Geometry – Unit 3, Module A

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
G.GPE.B.4 Use coordinates to prove simple geometric theorems algebraically. <i>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 $(0, 2)$.</i>	▪ prove simple geometric theorems algebraically using coordinates
G.GPE.B.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.	▪ prove the slope criteria for parallel lines ▪ use the slope criteria for parallel lines to solve geometric problems ▪ prove the slope criteria for perpendicular lines ▪ use the slope criteria for perpendicular lines to solve geometric problems
G.GPE.B.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.	▪ find the point that is between two given points on a directed line segment that partitions the segment in a given ratio
G.GPE.B.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*	▪ compute perimeter of polygons using coordinates ▪ compute areas of rectangles using coordinates ▪ compute area of triangles using coordinates

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Geometry – Unit 3, Module B

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
■ 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.	▪ define a circle based on some or all of the undefined notions of point, line, distance along a line, and distance around a circular arc
○ G.GPE.A.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.	▪ derive the equation of a circle given the center and radius using Pythagorean Theorem ▪ complete the square to find the center and radius of a circle given by an equation

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Geometry – Circles and Geometric Measurement – Unit 4

Rationale

In this final unit, learners engage more deeply with circles, exploring measurement in two and three dimensions, and apply their geometric understanding in modeling situations. In order to further explore circles, students will apply their understanding of similarity to consider the relationships among various angles, radii, and chords. They determine the relationship between central, inscribed, and circumscribed angles, and construct inscribed and circumscribed circles of a triangle. Learners are introduced to and define the radian measure of the angle as the constant of proportionality in the proportional relationship an angle and the length of the intercepted arc.

Learners extend their understanding of geometric measurement by giving informal arguments for various formulas and using volume formulas for cylinders, pyramids, cones, and spheres to solve problems. In the final module, learners use geometric shapes, their measures, and their properties to describe objects, apply concepts of density in modeling situations, and apply geometric methods to solve design problems.

Geometry – Unit 4, Module A

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
○ G.C.A.1 Prove that all circles are similar.	▪ prove that all circles are similar
○ G.C.A.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.	▪ identify and describe relationships among inscribed angles, radii, and chords ▪ identify and describe relationships among inscribed angles, central angles, and circumscribed angles ▪ the radius of a circle is perpendicular to the tangent where the radius intersects the circle ▪ inscribed angles on a diameter are right angles
○ G.C.B.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.	▪ use similarity to derive the fact that the length of the arc intercepted by an angle is proportional to the radius of a circle ▪ define the radian measure of an angle as the constant of proportionality between the length of the arc intercepted by an angle and the radius of a circle ▪ derive the formula for the area of a sector

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Standard	Student Learning Objectives We are learning to ... / We are learning that ...
○ G.C.A.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.	▪ construct the inscribed and circumscribed circles of a triangle ▪ prove properties of angles for a quadrilateral inscribed in a circle

Geometry – Unit 4, Module B

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
○ G.GMD.A.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.	▪ give an informal argument for the formulas for the circumference of a circle and for the area of a circle, using dissection arguments, Cavalieri’s principle, and informal limit arguments ▪ give an informal argument for the formula for the volume of a cylinder, pyramid, and cone using dissection arguments, Cavalieri’s principle, and informal limit arguments
○ G.GMD.A.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*	▪ use volume formulas for cylinders, pyramids, cones, and spheres to solve problems
○ G.GMD.B.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.	▪ identify three-dimensional objects generated by rotations of two-dimensional objects ▪ identify the shapes of two-dimensional cross-sections of three-dimensional objects

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Geometry – Unit 4, Module C

Standard	Student Learning Objectives We are learning to ... / We are learning that ...
■ G.MG.A.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).★	describe real-world objects using geometric shapes, their measures, and their properties
■ G.MG.A.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).★	apply concepts of density based on area and volume in modeling situations
■ G.MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).★	apply geometric methods to solve design problems