Ohio Mathematics - Extended Learning Standards

Geometry

Congruence

Experiment with transformations in the plane.

1 Know precise definitions of ray, angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and arc length. G.CO.1

Complexity a

a Identify points, lines, line segments, angles (right, acute, obtuse, and order by size), and perpendicular and parallel lines. G.CO.1.A

Complexity b

b Identify points, lines, line segments and angles (right, acute, obtuse, and order by size). G.CO.1.B

Complexity c

c Identify points, lines, and line segments, and order angles by size. G.CO.1.C

Learning Progression

- Understand that an angle is created by two (straight) rays that meet at a point G.CO.1.LP.A
- Draw geometric figures (e.g. points, lines, line segments and angles) G.CO.1.LP.B
- Recognize different angles in real - world situations G.CO.1.LP.C
- Use manipulatives to create angles and recognize that the size of the angle is related to the amount of rotation of the initial ray. G.CO.1.LP.D
- Engagement Statements (demonstration of engaged in the topic) G.CO.1.LP.E
- Interact with geometric figures (e.g. points, lines, rays, line segments and angles). G.CO.1.LP.F
- Interact with line segments and angles in the real world. G.CO.1.LP.G

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.2

Complexity a

a Demonstrate that a rotation (turn), a reflection (flip), or a translation (slide) maps a figure onto another. G.CO.2.A

Complexity b

b Identify whether a rotation (turn), a reflection (flip), or a translation (slide) can map a figure onto another. G.CO.2.B

Complexity c

c Match shapes in different orientations. (i.e., shapes = 2D) G.CO.2.C

Learning Progression

- [Between levels b and c: G.CO.2.LP.A
- Recognize the orientation of objects using terms such as above, below, in front of, behind, and next to.] G.CO.2.LP.B
- Match drawings of shapes having the same orientation. G.CO.2.LP.C
- Match shapes using manipulatives. G.CO.2.LP.D
- Recognize objects in the environment using names of shapes. G.CO.2.LP.E
- Engagement Statements (demonstration of engaged in the topic) G.CO.2.LP.F
- Interact with a variety of shapes (e.g. using pattern blocks) G.CO.2.LP.G

3 Identify the symmetries of a figure, which are the rotations and reflections that carry it onto itself. a. Identify figures that have line symmetry; draw and use lines of symmetry to analyze properties of shapes. b. Identify figures that have rotational symmetry; determine the angle of rotation, and use rotational symmetry to analyze properties of shapes. G.CO.3

Complexity a

a Show that two figures have symmetry on a coordinate plane. G.CO.3.A

Complexity b

b Identify figures that have line symmetry or rotational symmetry, using concrete objects or on a coordinate plane. G.CO.3.B

Complexity c

c Given visual models, determine which figures have line symmetry. (i.e., figure =3D) G.CO.3.C

Learning Progression

- Sort photos of real - world shapes with and without line symmetry. G.CO.3.LP.A
- Identify shapes without line symmetry. G.CO.3.LP.B
- Explore the concept of line symmetry in the real - world. G.CO.3.LP.C
- Engagement Statements (demonstration of engaged in the topic) G.CO.3.LP.D
- Interact with shapes. G.CO.3.LP.E
- Interact with visual models of shapes with line symmetry. G.CO.3.LP.F
- Observe a demonstration of shape folding, using shapes with and without line symmetry. G.CO.3.LP.G

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

Complexity a

a Identify that a translation requires a direction and distance; a rotation requires a center and angle; and a reflection requires a line. G.CO.4.A

Complexity b

b Identify whether a transformed figure is a “translation,” “reflection,” or “rotation.” G.CO.4.B

Complexity c

c Identify whether a transformed figure is a “slide,” “flip,” or “turn.” G.CO.4.C

Learning Progression

- Match drawings of figures having the same and different orientation. G.CO.4.LP.A
- Experience different rigid transformations in combination with the vocabulary. G.CO.4.LP.B
- Match the figures’ orientation with the type of the transformation. G.CO.4.LP.C
- Demonstrate with hand movement or technology what the terms, slide, flip, and turn mean. G.CO.4.LP.D
- Engagement Statements (demonstration of engaged in the topic) G.CO.4.LP.E
- Interact with a variety of 2D - shapes (e.g. using pattern blocks) including angles and line segments. G.CO.4.LP.F
- Observe a demonstration of transformations using technology and manipulatives. G.CO.4.LP.G

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

Complexity a

a Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure. G.CO.5.A

Complexity b

b Given visuals or real-world items, demonstrate a rotation (turn), a reflection (flip), or a translation (slide). G.CO.5.B

Complexity c

c Match shapes in different orientations. G.CO.5.C

Learning Progression

- [Between levels b and c: G.CO.5.LP.A
- Recognize the orientation of shapes using terms such as slide, flip, and turn.] G.CO.5.LP.B
- Match drawings of shapes having the same orientation. G.CO.5.LP.C
- Match shapes using manipulatives. G.CO.5.LP.D

- Recognize shapes in the environment using the names of shapes. G.CO.5.LP.E
- Experience different rigid transformations in combination with the vocabulary. G.CO.5.LP.F
- Match the shapes' orientation with the type of the transformation G.CO.5.LP.G
- Engagement Statements (demonstration of engaged in the topic) G.CO.5.LP.H
- Interact with a variety of shapes (e.g. using pattern blocks) G.CO.5.LP.I

Understand congruence in terms of rigid motions.

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.6

Complexity a

a Identify a basic rigid motion (a rotation (turn), a reflection (flip), or a translation (slide) that maps one figure onto another. (Restrict to situations in which a single basic rigid motion suffices.) G.CO.6.A

Complexity b

b Show two figures are congruent by demonstrating that a rotation (turn), a reflection (flip), or a translation (slide) maps one onto the other. G.CO.6.B

Complexity c

c Match shapes to show congruence by placing one figure on top of the other. G.CO.6.C

Learning Progression

- Recognize congruent shapes. G.CO.6.LP.A
- Experience different rigid transformations G.CO.6.LP.B
- Match the shapes' orientation with the type of the transformation, in combination with the vocabulary, flip, slide, and turn. G.CO.6.LP.C
- Recognize when two similar shapes are the same size or not. G.CO.6.LP.D
- Recognize shapes that are the same. G.CO.6.LP.E
- Engagement Statements (demonstration of engaged in the topic) G.CO.6.LP.F
- Interact with a variety of 2D - shapes, including angles and line segments G.CO.6.LP.G
- Observe demonstrations of shapes mapping onto each other or not, using technology or manipulatives. G.CO.6.LP.H

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.7

Complexity a

a Identify whether a rotation (turn), a reflection (flip), or a translation (slide) is required to show that a triangle is congruent to another triangle on a coordinate plane. Limit to one transformation. G.CO.7.A

Complexity b

b Identify whether a rotation (turn), a reflection (flip), or a translation (slide) is required to show that a triangle is congruent to another triangle. Limit to one transformation. G.CO.7.B

Complexity c

c Match triangles in different orientations. G.CO.7.C

Learning Progression

- [Between levels c and b: G.CO.7.LP.A
- Recognize congruent triangles.] G.CO.7.LP.B
- Experience different rigid transformations. G.CO.7.LP.C
- Match the triangles' orientation with the type of the transformation, in combination with the vocabulary, flip, slide, and turn. G.CO.7.LP.D
- Match drawings of triangles having the same orientations. G.CO.7.LP.E
- Recognize when two similar triangles are the same size or not. G.CO.7.LP.F
- Recognize triangles that are the same shape. G.CO.7.LP.G
- Identify triangles. G.CO.7.LP.H
- G.CO.10 needs to be taught before G.CO.7 G.CO.7.LP.I
- Engagement Statements (demonstration of engaged in the topic) G.CO.7.LP.J
- Interact with a variety of triangles, including angles and line segments G.CO.7.LP.J
- Observe demonstrations of triangles mapping onto each other or not, using technology or manipulatives. G.CO.7.LP.J

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

Complexity a

a Determine whether two triangles are congruent using ASA, SAS, or SSS. G.CO.8.A

Complexity b

b Match corresponding parts (sides and angles) of congruent triangles. G.CO.8.B

Complexity c

c Match one corresponding part (side or angle) of two congruent triangles. G.CO.8.C

Learning Progression

- Given two congruent triangles with different orientations, identify a corresponding angle or side. G.CO.8.LP.A
- Recognize corresponding parts - sides and angles G.CO.8.LP.B
- Recognize angles and sides of a triangle. G.CO.8.LP.C
- Understand that an angle in a triangle is created by two sides that meet at a point (vertex) G.CO.8.LP.D
- G.CO.10 needs to be taught first. G.CO.8.LP.E
- Engagement Statements (demonstration of engaged in the topic) G.CO.8.LP.F
- Interact with a variety of congruent triangles. G.CO.8.LP.G

- Observe demonstrations of triangles mapping onto each other or not, using technology or manipulatives. G.CO.8.LP.H

Prove geometric theorems both formally and informally using a variety of methods.

9 Prove and apply theorems about lines and angles. Theorems include but are not restricted to the following: 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.9

Complexity a

a1 Identify a pair of vertical, complementary, supplementary, corresponding, alternative interior, or alternate exterior angles. G.CO.9.A1

a2 Find a missing angle measure for situations involving vertical, complementary, supplementary, corresponding, alternative interior, and alternative exterior angles. G.CO.9.A2

Complexity b

b1 Given a pair of vertical angles and a missing angle measurement, find the missing angle measure. G.CO.9.B1

b2 Bisect a line segment using a ruler, compass, technology, or other means and label the midpoint. G.CO.9.B2

b3 Create a pair of perpendicular lines using a ruler, compass, technology or other means. Include the right-angle marking. G.CO.9.B3

Complexity c

c1 Identify vertical angles. G.CO.9.C1

c2 Identify a set of perpendicular lines. G.CO.9.C2

c3 Identify the midpoint of a line segment. Identify a right angle. G.CO.9.C3

Learning Progression

- Recognize or draw intersecting lines. G.CO.9.LP.A
- Sort intersecting lines by angles that meet perpendicular or not. G.CO.9.LP.B
- Among intersecting lines recognize the special case of perpendicular lines. G.CO.9.LP.C
- Discover vertical angles. G.CO.9.LP.D
- Discover right angles/square corners. G.CO.9.LP.E
- Understand that angles are created by two lines that meet at a point. G.CO.9.LP.F
- Recognize angles formed by intersecting lines. G.CO.9.LP.G
- Understand that the midpoint is equal distance from each end point. G.CO.9.LP.H
- Manipulate a drawn line segment, drawn on e.g., patty paper, to recognize the midpoint. G.CO.9.LP.I
- Identify a line segment. G.CO.9.LP.J

- Identify a line. G.CO.9.LP.K
- Engagement Statements (demonstration of engaged in the topic) G.CO.9.LP.L
- Interact with a variety of intersecting lines. G.CO.9.LP.M

10 Prove and apply theorems about triangles. Theorems include but are not restricted to the following: 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.10

Complexity a

a Determine the sum of the measures of the interior angles of a triangle. Identify congruent angles in isosceles and equilateral triangles. G.CO.10.A

Complexity b

b Identify right, equilateral, and isosceles triangles. G.CO.10.B

Complexity c

c Identify a triangle. G.CO.10.C

Learning Progression

- Understand that a triangle is a closed shape. G.CO.10.LP.A
- Understanding a triangle has three points (vertices) and three sides. G.CO.10.LP.B
- Sort a variety of shapes to recognize triangles. G.CO.10.LP.C
- Count the number of sides of a shape. G.CO.10.LP.D
- Count the number of angles of a shape. G.CO.10.LP.E
- Engagement Statements (demonstration of engaged in the topic) G.CO.10.LP.F
- Interact with a variety of shapes to recognize triangles. G.CO.10.LP.G

11 Prove and apply theorems about parallelograms. Theorems include but are not restricted to the following: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals. G.CO.11

Complexity a

a Identify the congruent sides and angles of a parallelogram. G.CO.11.A

Complexity b

b Identify congruent sides on a parallelogram. G.CO.11.B

Complexity c

c Identify a rectangle and a parallelogram. G.CO.11.C

Learning Progression

- Sort quadrilaterals based on the presence or absence of right angles. G.CO.11.LP.A

- Discover right angles/square corners. G.CO.11.LP.B
- Understand that a quadrilateral is a closed shape. G.CO.11.LP.C
- Sort a variety of figures to recognize quadrilaterals. G.CO.11.LP.D
- Sort quadrilaterals and describe their rule. G.CO.11.LP.E
- Count the number of sides of a shape. G.CO.11.LP.F
- Count the number of angles of a shape. G.CO.11.LP.G
- Engagement Statements (demonstration of engaged in the topic) G.CO.11.LP.H
- Interact with a variety of shapes to recognize quadrilaterals. G.CO.11.LP.I

Make geometric constructions.

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.12

Complexity a

a Construct a circle given a center and a radius. Copy a segment. G.CO.12.A

Complexity b

b Construct a line segment given its endpoints. G.CO.12.B

Complexity c

c Identify geometric tools (e.g., straightedge, protractor, and ruler) and their uses. G.CO.12.C

Learning Progression

- Match tools with drawings and their names. G.CO.12.LP.A
- Observe the usage of geometric tools, e.g., straight edge, ruler, protractor, and compass. G.CO.12.LP.B
- Explore/use geometric tools. G.CO.12.LP.C
- Engagement Statements (demonstration of engaged in the topic) G.CO.12.LP.D
- Interact with geometric tools (e.g., straightedge, protractor, compass, and ruler) G.CO.12.LP.E

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

Complexity a

a Construct an equilateral triangle. G.CO.13.A

Complexity b

b Construct a circle given a center and point on the circle. G.CO.13.B

Complexity c

c Given three congruent line segments (or sticks), make an equilateral triangle. G.CO.13.C

Learning Progression

- Understand “congruent triangles” as being of equal sidelength and angle measures. G.CO.13.LP.A
- Interact with geometric tools (e.g., straightedge, protractor, and ruler). G.CO.13.LP.B
- Recognize and identify triangles with equal side lengths. G.CO.13.LP.C

- Sort triangles by equal or different side lengths. G.CO.13.LP.D
- Sort triangles by equal or different angle measures. G.CO.13.LP.E
- Use manipulatives to create triangles. G.CO.13.LP.F
- Recognize triangles in the real-world. G.CO.13.LP.G
- Engagement Statements (demonstration of engaged in the topic) G.CO.13.LP.H
- Interact with triangles in the real-world. G.CO.13.LP.I

14 Classify twodimensional figures in a hierarchy based on properties. G.CO.14

Complexity a

a Classify two-dimensional shapes based on their properties. G.CO.14.A

Complexity b

b Sort different types of quadrilaterals. G.CO.14.B

Complexity c

c Sort different types of triangles. G.CO.14.C

Learning Progression

- Recognize and identify triangles with equal side lengths. G.CO.14.LP.A
- Sort triangles by the presence or absence of a right angle, an angle larger than a right angle, or three angles smaller than a right angle. G.CO.14.LP.B
- Sort triangles by the number of equal side lengths. G.CO.14.LP.C
- Sort triangles by the number of equal angle measures. G.CO.14.LP.D
- Use manipulatives to create triangles. G.CO.14.LP.E
- Recognize triangles in the real-world. G.CO.14.LP.F
- Engagement Statements (demonstration of engaged in the topic) G.CO.14.LP.G
- Interact with triangles in the real-world. G.CO.14.LP.H
- Interact with and sort a variety of shapes to recognize triangles. G.CO.14.LP.I

Similarity Right Triangles and Trigonometry

Use complex numbers in polynomial identities and equations.

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

Complexity a

a Determine the dimensions of a figure after dilation. G.SRT.1.A

Complexity b

b Determine if a figure is bigger or smaller after dilation. G.SRT.1.B

Complexity c

c Compare 2 figures to determine if a dilation has occurred. G.SRT.1.C

Learning Progression

Not on BP

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.2

Complexity a

a Determine if figures are similar; describe or select why two figures are or are not similar. G.SRT.2.A

Complexity b

b Determine if two rectangles or triangles are similar. G.SRT.2.B

Complexity c

c Identify similar triangles. G.SRT.2.C

Learning Progression

Not on BP

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

Complexity a

a Identify similar triangles in different orientations. G.SRT.3.A

Complexity b

b Identify similar triangles. G.SRT.3.B

Complexity c

c Identify a triangle. G.SRT.3.C

Learning Progression

Not on BP

Prove and apply theorems both formally and informally involving similarity using a variety of methods.

4 Prove and apply theorems about triangles. Theorems include but are not restricted to the following: 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.4

Complexity a

a Identify different types of triangles. G.SRT.4.A

Complexity b

b Identify parts of a right triangle. G.SRT.4.B

Complexity c

c Identify a right angle in the environment. G.SRT.4.C

Learning Progression

Not on BP

5 Use congruence and similarity criteria for triangles to solve problems and to justify relationships in geometric figures that can be decomposed into triangles. G.SRT.5

Complexity a

a Identify if triangles are similar, or not, in a given geometric figure; G.SRT.5.A

Complexity b

b Identify if triangles are similar or not in a decomposed polygon; e.g., is triangle ABD similar to triangle DCA? G.SRT.5.B

Complexity c

c Identify similar triangles. G.SRT.5.C

Learning Progression

Not on BP

Define trigonometric ratios, and solve problems involving right triangles.

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.6

Complexity a

a Identify parts of a right triangle. G.SRT.6.A

Complexity b

b Identify right triangles. G.SRT.6.B

Complexity c

c Identify a triangle. G.SRT.6.C

Learning Progression

- Not on BP G.SRT.6.LP.A

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

Complexity a

a Identify parts of a right triangle. G.SRT.7.A

Complexity b

b Identify right triangles. G.SRT.7.B

Complexity c

c Identify an angle of a triangle. G.SRT.7.C

Learning Progression

Not on BP

8 Solve problems involving right triangles. a. Use trigonometric ratios and the Pythagorean theorem to solve right triangles in applied problems if one of the two acute angles and a side length is given. (G, M2) b. Use trigonometric ratios and the Pythagorean theorem to solve right triangles in applied problems. (A2, M3) G.SRT.8

Complexity a

a Construct a right triangle on a coordinate plane and label the parts. G.SRT.8.A

Complexity b

b Identify the parts of a right triangle (right angle, legs, and hypotenuse). G.SRT.8.B

Complexity c

c Given an assortment of triangles, identify right triangles. G.SRT.8.C

Learning Progression

Not on BP

Circles

Understand and apply theorems about circles.

1 Prove that all circles are similar using transformational arguments. G.C.1

Complexity a

a Compare two circles and determine how to change one to make it the same as the other (e.g., circle A needs to be enlarged to match circle B). G.C.1.A

Complexity b

b Label the parts of a circle. G.C.1.B

Complexity c

c Locate circles in the environment. G.C.1.C

Learning Progression

- Not on BP G.C.1.LP.A

2 Identify and describe relationships among angles, radii, chords, tangents, and arcs, and use them to solve problems. Include the relationship between central, inscribed, and circumscribed angles and their intercepted arcs; 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.2

Complexity a

a Use the radius of a circle to determine the length of the diameter and vice versa. G.C.2.A

Complexity b

b Identify parts of a circle (radius, diameter, circumference, chord, and arc). G.C.2.B

Complexity c

c Locate circles in the environment. G.C.2.C

Learning Progression

- Between level c and b: G.C.2.LP.A
- Recognize the difference between the circle (the points equal distance from the midpoint) and the area of the circle. G.C.2.LP.B
- Recognize circles in a collection of different shapes. G.C.2.LP.C
- Recognize that a circle is not a sphere. G.C.2.LP.D
- Know that a circle has no straight lines. G.C.2.LP.E
- Know that a circle has no vertices/corners). G.C.2.LP.F
- Engagement Statements (demonstration of engaged in the topic) G.C.2.LP.G
- Interact with a variety of shapes. G.C.2.LP.H

3 Construct the inscribed and circumscribed circles of a triangle, prove and apply the property tht opposite angles are supplementary for a quadrilateral inscribed in a circle. G.C.3

Complexity a

a Identify a circumscribed circle about a triangle. G.C.3.A

Complexity b

b Identify a circle inscribed in a triangle. G.C.3.B

Complexity c

c Identify a circle. G.C.3.C

Learning Progression

BP??

Find arc lengths and areas of sectors of circles.

4 Find arc lengths and areas of sectors of circles. a. Apply similarity to relate the length of an arc intercepted by a central angle to the radius. Use the relationship to solve problems. b. Derive the formula for the area of a sector, and use it to solve problems. G.C.4

Complexity a

a Identify the central angle of a circle. OR Apply the formula to the area of a sector (e.g., area of a slice of pie). G.C.4.A

Complexity b

b Identify the sector of a circle. G.C.4.B

Complexity c

c Identify the arc of a circle. G.C.4.C

Learning Progression

Not on BP

5 Derive formulas that relate degrees and radians, and convert between the two. (A2, M3) G.C.5

Complexity a

a Identify the central angle of a circle. G.C.5.A

Complexity b

b Identify the sector of a circle. G.C.5.B

Complexity c

c Identify the arc of a circle. G.C.5.C

Learning Progression

- Not on BP G.C.5.LP.A

Expressing Geometric Properties with Equations

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

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. G.GPE.1

Complexity a

a Identify the diameter of a circle. G.GPE.1.A

Complexity b

b Identify the radius of a circle. G.GPE.1.B

Complexity c

c Identify a circle. G.GPE.1.C

Learning Progression

Not on BP

Use coordinates to prove simple geometric theorems algebraically and to verify specific geometric statements.

4 Use coordinates to prove simple geometric theorems algebraically and to verify geometric relationships algebraically, including properties of special triangles, quadrilaterals, and circles. For example, determine if a figure defined by four given points in the coordinate plane is a rectangle; determine if a specific point lies on a given circle. (G, M2) G.GPE.4

Complexity a

a Find the perimeter of quadrilaterals drawn on a coordinate grid. G.GPE.4.A

Complexity b

b Identify shapes on a coordinate grid. G.GPE.4.B

Complexity c

c Identify special triangles, quadrilaterals, and circles. G.GPE.4.C

Learning Progression

Not on BP

5 Justify 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.5

Complexity a

a Describe the “rise and run” relationships between two perpendicular lines. G.GPE.5.A

Complexity b

b Identify the slopes of parallel and perpendicular lines in a coordinate grid. G.GPE.5.B

Complexity c

c Identify parallel and perpendicular lines in a coordinate grid. G.GPE.5.C

Learning Progression

- Use manipulatives to create parallel and perpendicular lines. G.GPE.5.LP.A
- Identify parallel lines in the real-world. G.GPE.5.LP.B
- Sort lines in to parallel and perpendicular. G.GPE.5.LP.C
- Sort intersecting lines by angles that meet perpendicular or not. G.GPE.5.LP.D
- Among intersecting lines recognize the special case of perpendicular lines. G.GPE.5.LP.E
- Discover right angles/square corners. G.GPE.5.LP.F
- Understand that angles are created by two lines that meet at a point. G.GPE.5.LP.G
- Recognize angles formed by intersecting lines. G.GPE.5.LP.H

- Identify a line. G.GPE.5.LP.I
- Engagement Statements (demonstration of engaged in the topic) G.GPE.5.LP.J
- Interact with manipulatives, eg., straws and skewers. G.GPE.5.LP.K
- Interact with a coordinate grid. G.GPE.5.LP.L

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

Complexity a

a Find the midpoint of a vertical or horizontal line on a coordinate grid. G.GPE.6.A

Complexity b

b Find the length of a vertical or horizontal line on a coordinate grid. G.GPE.6.B

Complexity c

c Identify points, lines, and line segments. G.GPE.6.C

Learning Progression

Not on BP

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

Complexity a

a Find the area and perimeter of shapes given on a coordinate grid. (Restrict to shapes with sides that are vertical or horizontal line segments.) G.GPE.7.A

Complexity b

b Find the perimeter of shapes given on a coordinate grid. (Restrict to shapes with sides that are vertical or horizontal line segments.) G.GPE.7.B

Complexity c

c Identify shapes on a coordinate grid. G.GPE.7.C

Learning Progression

- Use manipulatives to create shapes. G.GPE.7.LP.A
- Identify shapes in the real-world. G.GPE.7.LP.B
- Sort shapes. G.GPE.7.LP.C
- Engagement Statements (demonstration of engaged in the topic) G.GPE.7.LP.D
- Interact with manipulatives. G.GPE.7.LP.E
- Interact with a coordinate grid. G.GPE.7.LP.F
- Interact with physical objects that represent 2-D shapes in the real-world, e.g., the lid on a sandwich box, a window, etc. G.GPE.7.LP.G

Geometric Measurement and Dimension

Explain volume formulas, and use them to solve problems.

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

Complexity a

a Compare the volume of two objects with the same base but different heights and vice versa (e.g., Which cup can hold more water: the shorter or the taller cup; given the choice of different sized cubes, identify which would hold more). G.GMD.1.A

Complexity b

b Distinguish between objects that do and do not have volume. G.GMD.1.B

Complexity c

c Sort three-dimensional objects (cones, cylinders, spheres). G.GMD.1.C

Learning Progression

Not on BP

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

Complexity a

a Compare the volume of two objects with the same base but different heights and vice versa (e.g., Which cup can hold more water: the shorter or the taller cup; given the choice of different sized cubes, identify which would hold more). G.GMD.3.A

Complexity b

b Distinguish between objects that do and do not have volume. G.GMD.3.B

Complexity c

c Sort three-dimensional objects (cones, cylinders, spheres, pyramids). G.GMD.3.C

Learning Progression

Not on BP

Visualize relationships between two-dimensional and three-dimensional objects.

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

Complexity a

a Identify cross-sections of three- dimensional shapes. G.GMD.4.A

Complexity b

b Identify faces of threedimensional shapes. G.GMD.4.B

Complexity c

c Identify two- and threedimensional shapes. G.GMD.4.C

Learning Progression

Not on BP

Understand the relationships between length, area, and volume.

5 Understand how and when changes to the measures of a figure (lengths or angles) result in similar and non-similar figures. G.GMD.5

Complexity a

a Compare the volume of threedimensional shapes. G.GMD.5.A

Complexity b

b Compare the area of shapes. G.GMD.5.B

Complexity c

c Compare similar shapes. G.GMD.5.C

Learning Progression

Not on BP

6 When figures are similar, understand and apply the fact that when a figure is scaled by a factor of k, the effect on lengths, areas, and volumes is that they are multiplied by k, k2, and k3, respectively. G.GMD.6

Complexity a

a Find the volume of two similar threedimensional shapes. G.GMD.6.A

Complexity b

b Find the area of two similar shapes. G.GMD.6.B

Complexity c

c Identify similar shapes. G.GMD.6.C

Learning Progression

Not on BP

Modeling with Geometry

Apply geometric concepts in modeling situations.

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.1

Complexity a

a Connect the shape of real-world objects to twodimensional and three-dimensional shapes (e.g., the trunk of a tree is cylindrical in shape; a car is cube in shape; the center of a sunflower is circular in shape; a bookshelf is rectangular prism in shape). G.MG.1.A

Complexity b

b Connect the shape of realworld objects to twodimensional shapes (e.g., a window is rectangular in shape, a wheel is circular in shape, and a table can be of many different shapes). G.MG.1.B

Complexity c

c Connect two-dimensional shapes with realworld objects. G.MG.1.C

Learning Progression

Not on BP

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.2

Complexity a

a Calculate and compare the densities of two datasets in the same modeling situation (e.g, Is the population density of Ohio or New York greater?). G.MG.2.A

Complexity b

b Calculate the density of a given situation. G.MG.2.B

Complexity c

c Given representations of density, identify the one with the greatest or least density (e.g., If 3 squares of the same size have different numbers of dots in them, which one has the greatest number of dots?). G.MG.2.C

Learning Progression

Not on BP

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. G.MG.3

Complexity a

a Compare the volume of realworld objects. G.MG.3.A

Complexity b

b Compare the area of real-world objects. G.MG.3.B

Complexity c

c Sort shapes that model a real-world object (e.g., a baseball is a sphere, a can of soup is a cylinder). G.MG.3.C

Learning Progression

Not on BP