Illustrative Mathematics

Geometry

Taking the basic distance and angle-preserving properties of rigid motions and similarity transformations as axiomatic, students establish triangle congruence and similarity criteria, then use them to prove a wide variety of theorems and solve problems involving, for example, triangles, other polygons, and circles. Students study geometric measurement and solve problems involving length, area and volume, learning more sophisticated arguments for the circumference, area, and volume formulas that they learned in earlier grades. They use similarity of right triangles with given angle measures to define sine, cosine, and tangent in terms of side ratios. They prove theorems and solve problems about circles, segments, angles, and arcs.

Throughout the course, students use coordinates to connect geometry with algebra, and engage in mathematical modeling using geometric principles.

G.1 Constructions and Rigid Motions

• Know and be able to use precise definitions of geometric terms.
• Make formal geometric constructions by hand and using geometry software.
• Given a geometric figure and a rotation, reflection, or translation draw the transformed figure.
• Develop definitions of rotation, reflection, and translation.
• Represent transformations in the plane; describe transformations as functions whose inputs and outputs are points in the plane.
• Describe the rotations and reflections that carry a given quadrilateral or regular polygon onto itself.
• Prove that the measures of the interior angles of a triangle have sum 180°.

Students construct (with both compass and straight-edge and technology, rather than the physical models and transparencies used in eighth grade) perpendicular lines, parallel lines, and regular polygons, and develop formal definitions of these objects. Students then develop more precise definitions for translations, rotations, and reflections, and use these to describe symmetries - single rigid transformations that carry objects to themselves. Careful attention is given to properties of figures that are preserved (for example, as the result of a translation, a line segment is both parallel and congruent to the pre-image), as they will be important to following work with transformational proofs. Additionally, coordinates are used to represent rigid motions as functions that map points in the plane to points in the plane.

Students have worked with geometric shapes since kindergarten. In grade 4, they classified two-dimensional shapes by properties of their sides and angles, and in grade 5, they classified these shapes in a hierarchy based on properties. In grade 8, they were introduced to the concepts of rotation, reflection, and translation via physical models, transparencies, or geometry software. They defined congruence of two-dimensional figures in terms of these rigid motions, understanding that two figures were congruent if one could be obtained from the other via a sequence of rigid motions. Given a two-dimensional figure, students described the effect of a rotation, reflection, or translation on the figure in terms of coordinates. Students also worked with determining distances in the coordinate

plane using the Pythagorean Theorem.
In this unit, the focus is on more precise definitions for many of the geometric figures that students worked with before high school. These definitions are given in terms of a few undefined notions, in contrast to definitions that students may have used earlier (e.g., a square is a rectangle in which all sides have equal length). The unit begins by revisiting this prior knowledge. Next, students construct, by hand and using technology, perpendicular lines, parallel lines, equilateral triangles, squares, etc. and develop formal definitions of these objects. Students then continue to examine rigid motions in the plane. In the second part of the unit, students use coordinates to represent rigid motions as functions, that is, as mappings of points in the plane to points in the plane. The third part of the unit gives students an opportunity to attend to precision when describing shapes with various properties, e.g., a quadrilateral with exactly one rotation symmetry and no reflection symmetry.

In unit G2, students work with sequences of rigid motions, specifying sequences that will carry one figure onto another, thus addressing the second part of standard G-CO.A.5. Congruence is defined, as opposed to understood, in terms of such sequences. Students continue to see and use geometric constructions in units G2, G3, and G6, and work with geometric diagrams in all geometry units.

G.1.0 Pre-unit diagnostic assessment

Assess students' ability to

• draw geometric shapes that satisfy given conditions;
• given two congruent figures, describe a sequence that exhibits the congruence between them;
• describe the effects of rigid motions on two-dimensional figures using coordinates.

Students construct (with both compass and straight-edge and technology, rather than the physical models and transparencies used in eighth grade) perpendicular lines, parallel lines, and regular polygons, and develop formal definitions of these objects. Students then develop more precise definitions for translations, rotations, and reflections, and use these to describe symmetries - single rigid transformations that carry objects to themselves. Careful attention is given to properties of figures that are preserved (for example, as the result of a translation, a line segment is both parallel and congruent to the pre-image), as they will be important to following work with transformational proofs. Additionally, coordinates are used to represent rigid motions as functions that map points in the plane to points in the plane.

G.1.1 Definitions and Geometry

Recall and reconnect with the meanings of geometry terms that will be used in this unit.

Students construct (with both compass and straight-edge and technology, rather than the physical models and transparencies used in eighth grade) perpendicular lines, parallel lines, and regular polygons, and develop formal definitions of these objects. Students then develop more precise definitions for translations, rotations, and reflections, and use these to describe symmetries - single rigid transformations that carry objects to themselves. Careful attention is given to properties of figures that are preserved (for example, as the result of a translation, a line segment is both parallel and congruent to the pre-image), as they will be important to following work with transformational proofs. Additionally, coordinates are used to represent rigid motions as functions that map points in the plane to points in the plane.

G.1.2 Introduction to Constructions

• Use a compass and a straightedge to construct various geometric figures.
• Use geometric software to construct various geometric figures.
• Begin to understand the formal definitions of geometric figures through constructions.

Students construct (with both compass and straight-edge and technology, rather than the physical models and transparencies used in eighth grade) perpendicular lines, parallel lines, and regular polygons, and develop formal definitions of these objects. Students then develop more precise definitions for translations, rotations, and reflections, and use these to describe symmetries - single rigid transformations that carry objects to themselves. Careful attention is given to properties of figures that are preserved (for example, as the result of a translation, a line segment is both parallel and congruent to the pre-image), as they will be important to following work with transformational proofs. Additionally, coordinates are used to represent rigid motions as functions that map points in the plane to points in the plane.

G.1.3 Representing transformations

• Draw the result of a rotation, reflection, or translation on given geometric figures by hand.
• Draw the result of a rotation, reflection, or translation on given geometric figures using geometric software.
• Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

Students construct (with both compass and straight-edge and technology, rather than the physical models and transparencies used in eighth grade) perpendicular lines, parallel lines, and regular polygons, and develop formal definitions of these objects. Students then develop more precise definitions for translations, rotations, and reflections, and use these to describe symmetries - single rigid transformations that carry objects to themselves. Careful attention is given to properties of figures that are preserved (for example, as the result of a translation, a line segment is both parallel and congruent to the pre-image), as they will be important to following work with transformational proofs. Additionally, coordinates are used to represent rigid motions as functions that map points in the plane to points in the plane.

Tasks

G-CO Reflected Triangles
G-CO Defining Reflections
G-CO Defining Rotations
G-CO Sum of angles in a triangle

G.1.4 Mid-Unit Assessment

Assess students' ability to

• make formal geometric constructions (copying a segment);
• construct a square;
• given a geometric figure and a rotation, reflection or translation draw the transformed figure;
• understand and explain the formal definition of rotation.

Students construct (with both compass and straight-edge and technology, rather than the physical models and transparencies used in eighth grade) perpendicular lines, parallel lines, and regular polygons, and develop formal definitions of these objects. Students then develop more precise definitions for translations, rotations, and reflections, and use these to describe symmetries - single rigid transformations that carry objects to themselves. Careful attention is given to properties of figures that are preserved (for example, as the result of a translation, a line segment is both parallel and congruent to the pre-image), as they will be important to following work with transformational proofs. Additionally, coordinates are used to represent rigid motions as functions that map points in the plane to points in the plane.

G.1.5 Mappings of the plane

• Represent transformations in the plane using various tools (transparencies, geometry software, etc.).
• Describe transformations as functions that take points in the plane as inputs and given other points as outputs.
• Compare transformations that preserve distance and angle and those that do not (translation vs. horizontal stretch).

Students construct (with both compass and straight-edge and technology, rather than the physical models and transparencies used in eighth grade) perpendicular lines, parallel lines, and regular polygons, and develop formal definitions of these objects. Students then develop more precise definitions for translations, rotations, and reflections, and use these to describe symmetries - single rigid transformations that carry objects to themselves. Careful attention is given to properties of figures that are preserved (for example, as the result of a translation, a line segment is both parallel and congruent to the pre-image), as they will be important to following work with transformational proofs. Additionally, coordinates are used to represent rigid motions as functions that map points in the plane to points in the plane.

Tasks

G-CO Horizontal Stretch of the Plane

G.1.6 Symmetries

• Understand the idea of reflection symmetry.
• Understand the idea of rotation symmetry.
• Be able to describe the rotations and reflections that carry a given rectangle, parallelogram, trapezoid, or regular polygon onto itself.

Students construct (with both compass and straight-edge and technology, rather than the physical models and transparencies used in eighth grade) perpendicular lines, parallel lines, and regular polygons, and develop formal definitions of these objects. Students then develop more precise definitions for translations, rotations, and reflections, and use these to describe symmetries - single rigid transformations that carry objects to themselves. Careful attention is given to properties of figures that are preserved (for example, as the result of a translation, a line segment is both parallel and congruent to the pre-image), as they will be important to following work with transformational proofs. Additionally, coordinates are used to represent rigid motions as functions that map points in the plane to points in the plane.

Tasks

G-CO Seven Circles II
G-CO Symmetries of a quadrilateral I
G-CO Symmetries of a quadrilateral II
G-CO Symmetries of rectangles

G.1.7 Bringing it all together

Create a given design through construction and rigid motions.

Students construct (with both compass and straight-edge and technology, rather than the physical models and transparencies used in eighth grade) perpendicular lines, parallel lines, and regular polygons, and develop formal definitions of these objects. Students then develop more precise definitions for translations, rotations, and reflections, and use these to describe symmetries - single rigid transformations that carry objects to themselves. Careful attention is given to properties of figures that are preserved (for example, as the result of a translation, a line segment is both parallel and congruent to the pre-image), as they will be important to following work with transformational proofs. Additionally, coordinates are used to represent rigid motions as functions that map points in the plane to points in the plane.

G.1.8 Summative Assessment

Assess students' ability to

- **give definitions of geometric terms;**
- **make formal geometric constructions (parallel and perpendicular lines);**
- **construct a square and explain why the construction yields a square;**
- **given a geometric figure and a rotation, reflection or translation draw the transformed figure;**
- **understand and explain the formal definition of rotation;**
- **describe transformations as functions;**
- **given a square or trapezoid, describe the rotations and reflections that map it onto itself.**

Students construct (with both compass and straight-edge and technology, rather than the physical models and transparencies used in eighth grade) perpendicular lines, parallel lines, and regular polygons, and develop formal definitions of these objects. Students then develop more precise definitions for translations, rotations, and reflections, and use these to describe symmetries - single rigid transformations that carry objects to themselves. Careful attention is given to properties of figures that are

preserved (for example, as the result of a translation, a line segment is both parallel and congruent to the pre-image), as they will be important to following work with transformational proofs. Additionally, coordinates are used to represent rigid motions as functions that map points in the plane to points in the plane.

G.2 Congruence

• Specify sequences of rigid motions that will carry a figure onto another.
• Understand that there can be more than one sequence of rigid motions that carries a figure onto another figure.
• Use the definition of congruence in terms of rigid motions to decide if two figures are congruent.
• 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 (CPCTC).
• Be able to explain how the criteria for triangle congruence follow from the definition of congruence in terms of rigid motions.
• Prove theorems about lines and angles.
• Prove theorems about parallelograms.
• Prove base angles of isosceles triangles are congruent.

Students build on their understanding of rigid motions to formalize the definition of congruence that they developed in grade 8. They specify a series of rigid motions that carries one figure onto another and use the definition to determine whether two objects are congruent. Students show two triangles are congruent if and only if corresponding pairs of sides and angles are congruent. They explain how the criteria for triangle congruence (ASA, SAS, SSS) follow from the definition of congruence in terms of rigid motions. Armed with these criteria, students are able to prove theorems about triangles, lines, angles, and parallelograms.

In the preceding unit, students built on their middle grades experiences with geometry. They made formal geometric constructions and developed definitions for rigid motions (translations, rotations, reflections) and several key geometric terms. Students examined the effects of single rigid motions on figures, considering rigid motions as mappings of the coordinate plane to itself. Given simple figures, they described symmetries of those figures—the rotations and reflections that mapped the figures onto themselves. In this unit, students build on their understanding of rigid motions to strengthen the understanding of congruence that they developed in grade 8. Students use this definition to show that two triangles are congruent if and only if corresponding pairs of sides and angles are congruent. They explain how the criteria for triangle congruence (ASA, SAS, SSS) follow from the definition of congruence in terms of rigid motions. They use these criteria to prove theorems about triangles, lines, angles, and parallelograms. In the next unit, students extend their knowledge of transformations to include dilations. They explore properties of dilations, use this knowledge to understand similarity in triangles and other shapes in terms of transformations, and use this understanding to solve problems.

G.2.0 Pre-unit diagnostic assessment

Assess students' ability to

• make formal geometric constructions (parallel and perpendicular lines;
• construct a square and explain why the construction yields a square.

Students build on their understanding of rigid motions to formalize the definition of congruence that they developed in grade 8. They specify a series of rigid motions that carries one figure onto another and use the definition to determine whether two objects are congruent. Students show two triangles are congruent if and only if corresponding pairs of sides and angles are congruent. They explain how the criteria for triangle congruence (ASA, SAS, SSS) follow from the definition of congruence in terms of rigid motions. Armed with these criteria, students are able to prove theorems about triangles, lines, angles, and parallelograms.

G.2.1 Sequences of rigid motions

• Specify sequences of rigid motions that will carry a figure onto another.
• Find different ways to transform one figure into another.
• Given a sequence of rigid motions, try to find a shorter sequence of rigid motions with the same outcome.

Students build on their understanding of rigid motions to formalize the definition of congruence that they developed in grade 8. They specify a series of rigid motions that carries one figure onto another and use the definition to determine whether two objects are congruent. Students show two triangles are congruent if and only if corresponding pairs of sides and angles are congruent. They explain how the criteria for triangle congruence (ASA, SAS, SSS) follow from the definition of congruence in terms of rigid motions. Armed with these criteria, students are able to prove theorems about triangles, lines, angles, and parallelograms.

G.2.2 Defining Congruence

• Use the definition of congruence in terms of rigid motions.
• Use the definition of congruence to decide if two figures are congruent or not.

Students build on their understanding of rigid motions to formalize the definition of congruence that they developed in grade 8. They specify a series of rigid motions that carries one figure onto another and use the definition to determine whether two objects are congruent. Students show two triangles are congruent if and only if corresponding pairs of sides and angles are congruent. They explain how the criteria for triangle congruence (ASA, SAS, SSS) follow from the definition of congruence in terms of rigid motions. Armed with these criteria, students are able to prove theorems about triangles, lines, angles, and parallelograms.

G.2.3 Triangle Congruence Criteria

• 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 (CPCTC).
• Explain how the criteria for triangle congruence follow from the definition of congruence.
• Prove that base angles of isosceles triangles are congruent.

Students build on their understanding of rigid motions to formalize the definition of congruence that they developed in grade 8. They specify a series of rigid motions that carries one figure onto another and use the definition to determine whether two objects are congruent. Students show two triangles are congruent if and only if corresponding pairs of sides and angles are congruent. They explain how the criteria for triangle congruence (ASA, SAS, SSS) follow from the definition of congruence in terms of rigid motions. Armed with these criteria, students are able to prove theorems about triangles, lines, angles, and parallelograms.

Tasks

G-CO Properties of Congruent Triangles
G-CO Why does SAS work?
G-CO Why Does ASA Work?
G-CO When Does SSA Work to Determine Triangle Congruence?
G-CO Why does SSS work?
G-CO Angle bisection and midpoints of line segments
G-CO Congruent angles in isosceles triangles

G.2.4 More Congruence Theorems

- **Prove theorems about lines and angles.**
- **Prove theorems about parallelograms.**

Students build on their understanding of rigid motions to formalize the definition of congruence that they developed in grade 8. They specify a series of rigid motions that carries one figure onto another and use the definition to determine whether two objects are congruent. Students show two triangles are congruent if and only if corresponding pairs of sides and angles are congruent. They explain how the criteria for triangle congruence (ASA, SAS, SSS) follow from the definition of congruence in terms of rigid motions. Armed with these criteria, students are able to prove theorems about triangles, lines, angles, and parallelograms.

Tasks

G-CO Points equidistant from two points in the plane
G-CO, G-SRT Congruence of parallelograms

G.2.5 Summative Assessment

Assess students' ability to

- **show and explain sequences of rigid motions and analyze different**

sequences of rigid motions that carry one shape to another;
• explain the criteria for triangle congruence and whether given triangles are congruent or not;
• understand and explain that opposite sides of a parallelogram are congruent;
• explain that vertical angles are congruent;
• explain that when a transversal crosses parallel lines, alternate interior and corresponding angles are congruent.

Students build on their understanding of rigid motions to formalize the definition of congruence that they developed in grade 8. They specify a series of rigid motions that carries one figure onto another and use the definition to determine whether two objects are congruent. Students show two triangles are congruent if and only if corresponding pairs of sides and angles are congruent. They explain how the criteria for triangle congruence (ASA, SAS, SSS) follow from the definition of congruence in terms of rigid motions. Armed with these criteria, students are able to prove theorems about triangles, lines, angles, and parallelograms.

Tasks

G-CO Showing a triangle congruence: a particular case
G-CO Are the Triangles Congruent?
G-CO Midpoints of the Sides of a Paralellogram
G-CO Congruent angles made by parallel lines and a transverse

G.3 Similarity

• Verify experimentally properties of dilations, and use center and scale factor to describe them.
• Use the definition of similarity to decide if two figures are similar.
• Use the properties of similarity to establish AA criterion for two triangles to be similar.
• Prove and use some theorems about triangles.
• Prove and use slope criteria for parallel and perpendicular lines.
• Construct points that partition a segment in a given ratio.
• Explore why all circles are similar.

Students describe dilations in terms of center and scale factor and use these terms to describe properties of dilations (for example, as a result of a dilation, the image of a line segment that does not include the center of dilation is parallel to its pre-image, with a proportional length determined by the scale factor). As in unit G1, students work with concepts from grade 8, but now use constructions created by hand or with software rather than physical models and transparencies. They develop a more precise definition of similarity in terms of a dilation, drawing on their knowledge of proportional relationships developed in grades 6 and 7. Students also use the definition of similarity to show that two objects are similar and establish the AA criterion for triangle similarity. With this knowledge they then prove and use theorems about triangles, prove and use slope criteria for parallel and perpendicular lines, construct points that partition a line segment into a given ratio, and explore why all circles are similar.

In units G1 and G2, students worked with rigid motions: translations, rotations, and reflections. They used these to show congruences between triangles, and prove theorems, after defining congruence in terms of transformations. In grade 8, they used physical models, transparencies, and geometry software to understand congruence and similarity in terms of transformations, and described the effects of transformations on given two-dimensional figures in terms of coordinates for the figures. As in unit G2, students work with concepts from grade 8, but use constructions, by hand or with software, rather than physical models and transparencies. This unit also draws on the knowledge of proportional relationships that students developed in grades 6 and 7. In this unit, students describe dilations in terms of center and scale factor, and use these terms to describe properties of dilations. They use these properties to solve problems and prove theorems. In the next unit, students extend their knowledge of similar triangles to build an understanding of the trigonometric ratios and use these ratios to solve problems involving right triangles.

G.3.0 Pre-unit diagnostic assessment

Assess students' ability to

• draw the transformed figure, given a figure and a reflection, rotation, or translation;
• show that two figures are congruent by describing a series of rigid motions that map one onto another.

Students describe dilations in terms of center and scale factor and use these terms to describe properties of dilations (for example, as a result of a dilation, the image of a line segment that does not include the center of dilation is parallel to its pre-image, with a proportional length determined by the scale factor). As in unit G1, students work with concepts from grade 8, but now use constructions created by hand or with software rather than physical models and transparencies. They develop a more precise definition of similarity in terms of a dilation, drawing on their knowledge of proportional relationships developed in grades 6 and 7. Students also use the definition of similarity to show that two objects are similar and establish the AA criterion for triangle similarity. With this knowledge they then prove and use theorems about triangles, prove and use slope criteria for parallel and perpendicular lines, construct points that partition a line segment into a given ratio, and explore why all circles are similar.

G.3.1 Motivate the need for similarity

Understand the properties of dilations in order to solve a problem.

Students describe dilations in terms of center and scale factor and use these terms to describe properties of dilations (for example, as a result of a dilation, the image of a line segment that does not include the center of dilation is parallel to its pre-image, with a proportional length determined by the scale factor). As in unit G1, students work with concepts from grade 8, but now use constructions created by hand or with software rather than physical models and transparencies. They develop a more precise definition of similarity in terms of a dilation, drawing on their knowledge of proportional relationships developed in grades 6 and 7. Students also use the definition of similarity to show that two objects are similar and establish the AA criterion for triangle similarity. With this knowledge they then prove and use theorems about triangles, prove and use slope criteria for parallel and perpendicular lines, construct points that partition a line segment into a given ratio, and explore why all circles are similar.

G.3.2 Properties of dilations

- **Verify experimentally the properties of a dilation.**
- **Produce a transformed figure given an initial figure and scale factor.**

Students describe dilations in terms of center and scale factor and use these terms to describe properties of dilations (for example, as a result of a dilation, the image of a line segment that does not include the center of dilation is parallel to its pre-image, with a proportional length determined by the scale factor). As in unit G1, students work with concepts from grade 8, but now use constructions created by hand or with software rather than physical models and transparencies. They develop a more precise definition of similarity in terms of a dilation, drawing on their knowledge of proportional relationships developed in grades 6 and 7. Students also use the definition of similarity to show that two objects are similar and establish the AA criterion for triangle similarity. With this knowledge they then prove and use theorems about triangles, prove and use slope criteria for parallel and perpendicular lines, construct points that partition a line segment into a given ratio, and explore why all circles are similar.

Tasks

G-SRT Dilating a Line

G-GPE Scaling a Triangle in the Coordinate Plane

G.3.3 Introduction to similarity

Use the definition of similarity in terms of transformations.

Students describe dilations in terms of center and scale factor and use these terms to describe properties of dilations (for example, as a result of a dilation, the image of a line segment that does not include the center of dilation is parallel to its pre-image, with a proportional length determined by the scale factor). As in unit G1, students work with concepts from grade 8, but now use constructions created by hand or with software rather than physical models and transparencies. They develop a more precise definition of similarity in terms of a dilation, drawing on their knowledge of proportional relationships developed in grades 6 and 7. Students also use the definition of similarity to show that two objects are similar and establish the AA criterion for triangle similarity. With this knowledge they then prove and use theorems about triangles, prove and use slope criteria for parallel and perpendicular lines, construct points that partition a line segment into a given ratio, and explore why all circles are similar.

Tasks

G-SRT Congruent and Similar Triangles
G-SRT Similar Triangles
G-SRT Are They Similar?

G.3.4 Prove all circles are similar

Prove that all circles are similar.

Students describe dilations in terms of center and scale factor and use these terms to describe properties of dilations (for example, as a result of a dilation, the image of a line segment that does not include the center of dilation is parallel to its pre-image, with a proportional length determined by the scale factor). As in unit G1, students work with concepts from grade 8, but now use constructions created by hand or with software rather than physical models and transparencies. They develop a more precise definition of similarity in terms of a dilation, drawing on their knowledge of proportional relationships developed in grades 6 and 7. Students also use the definition of similarity to show that two objects are similar and establish the AA criterion for triangle similarity. With this knowledge they then prove and use theorems about triangles, prove and use slope criteria for parallel and perpendicular lines, construct points that partition a line segment into a given ratio, and explore why all circles are similar.

Tasks

G-C Similar circles

G.3.5 Mid-unit formative assessment

Assess students' ability to establish similarity of shapes by showing a series of transformations in the plane.

Students describe dilations in terms of center and scale factor and use these terms to describe properties of dilations (for example, as a result of a dilation, the image of a line segment that does not include the center of dilation is parallel to its pre-image, with a proportional length determined by the scale factor). As in unit G1, students work with concepts from grade 8, but now use constructions created by hand or with software rather than physical models and transparencies. They develop a more precise definition of similarity in terms of a dilation, drawing on their knowledge of proportional relationships developed in grades 6 and 7. Students also use the definition of similarity to show that two objects are similar and establish the AA criterion for triangle similarity. With this knowledge they then prove and use theorems about triangles, prove and use slope criteria for parallel and perpendicular lines, construct points that partition a line segment into a given ratio, and explore why all circles are similar.

G.3.6 Establish AA criterion for triangles

• Explore and establish the AA criterion for triangles, if two triangles with two pairs of angles congruent, then the triangles are similar.
• Consider the analogous question for quadrilaterals, i.e., "Is there an AAA criterion for quadrilaterals?"

Students describe dilations in terms of center and scale factor and use these terms to describe properties of dilations (for example, as a result of a dilation, the image of a line segment that does not include the center of dilation is parallel to its pre-image, with a proportional length determined by the scale factor). As in unit G1, students work with concepts from grade 8, but now use constructions created by hand or with software rather than physical models and transparencies. They develop a more precise definition of similarity in terms of a dilation, drawing on their knowledge of proportional relationships developed in grades 6 and 7. Students also use the definition of similarity to show that two objects are similar and establish the AA criterion for triangle similarity. With this knowledge they then prove and use theorems about triangles, prove and use slope criteria for parallel and perpendicular lines, construct points that partition a line segment into a given ratio, and explore why all circles are similar.

Tasks

G-SRT Similar triangles

G-SRT Similar Quadrilaterals

G.3.7 Prove theorems about triangles using similarity

• Prove that a line parallel to one side of a triangle partitions the other two sides proportionally.
• Prove the segment joining the midpoints of two sides of a triangle is parallel to the third side and half the length.
• Prove the Pythagorean Theorem using triangle similarity.
• Prove and use slope criteria for parallel and perpendicular lines.

Students describe dilations in terms of center and scale factor and use these terms to describe properties of dilations (for example, as a result of a dilation, the image of a line segment that does not include the center of dilation is parallel to its pre-image, with a proportional length determined by the scale factor). As in unit G1, students work with concepts from grade 8, but now use constructions created by hand or with software rather than physical models and transparencies. They develop a more precise definition of similarity in terms of a dilation, drawing on their knowledge of proportional relationships developed in grades 6 and 7. Students also use the definition of similarity to show that two objects are similar and establish the AA criterion for triangle similarity. With this knowledge they then prove and use theorems about triangles, prove and use slope criteria for parallel and perpendicular lines, construct points that partition a line segment into a given ratio, and explore why all circles are similar.

Tasks

G-CO Midpoints of Triangle Sides
G-SRT Pythagorean Theorem
G-GPE, G-SRT Slope Criterion for Perpendicular Lines
G-GPE Equal Area Triangles on the Same Base II

G.3.8 Use similarity to solve problems

Solve problems and prove relationships using properties of similar triangles.

Students describe dilations in terms of center and scale factor and use these terms to describe properties of dilations (for example, as a result of a dilation, the image of a line segment that does not include the center of dilation is parallel to its pre-image, with a proportional length determined by the scale factor). As in unit G1, students work with concepts from grade 8, but now use constructions created by hand or with software rather than physical models and transparencies. They develop a more precise definition of similarity in terms of a dilation, drawing on their knowledge of proportional relationships developed in grades 6 and 7. Students also use the definition of similarity to show that two objects are similar and establish the AA criterion for triangle similarity. With this knowledge they then prove and use theorems about triangles, prove and use slope criteria for parallel and perpendicular lines, construct points that partition a line segment into a given ratio, and explore why all circles are similar.

Tasks

G-SRT Tangent Line to Two Circles

G.3.9 Summative Assessment

Assess students' ability to meet the mathematical goals outlined at the

beginning of the unit.

Students describe dilations in terms of center and scale factor and use these terms to describe properties of dilations (for example, as a result of a dilation, the image of a line segment that does not include the center of dilation is parallel to its pre-image, with a proportional length determined by the scale factor). As in unit G1, students work with concepts from grade 8, but now use constructions created by hand or with software rather than physical models and transparencies. They develop a more precise definition of similarity in terms of a dilation, drawing on their knowledge of proportional relationships developed in grades 6 and 7. Students also use the definition of similarity to show that two objects are similar and establish the AA criterion for triangle similarity. With this knowledge they then prove and use theorems about triangles, prove and use slope criteria for parallel and perpendicular lines, construct points that partition a line segment into a given ratio, and explore why all circles are similar.

G.4 Right Triangle Trigonometry

• Using similarity, show that side ratios in right triangles are properties of the angles.
• Define the trigonometric ratios for acute angles.
• Explain and use the relationship between sine and cosine of complementary angles.
• Use trigonometric ratios to solve a variety of modeling problems.

After an open-ended task intended to motivate the need for trigonometric ratios (although the term is not used), students examine side ratios of similar right triangles. Students then build tables of side ratios for several similar triangles while noting that quotients of corresponding sides are the same. Using their knowledge of similar triangles they see that the ratios are a property of an angle rather than of a triangle. Only after laying this groundwork do students learn that, for right triangles, the ratios are called "sine," "cosine," and "tangent." Finally, students examine the relationship between sine and cosine and use this knowledge to solve a variety of problems.

In grades 6 and 7, students studied ratios. In those grades, a ratio is a pair of numbers. Two pairs are said to be "in the same ratio" if their quotients are equal. In previous geometry units, students have proved various theorems about triangles including "the sum of the measures of the interior angles of a triangle is 180°" and "the base angles of isosceles triangles are congruent." Students have established the AA criteria for similar triangles and have experience working with this theorem. At the end of unit G3, students used properties of similar triangles (proportionality of corresponding sides and congruence of corresponding angles) to solve problems. Traditionally, right angle trigonometry concerns quotients of side-lengths of triangles which are called ratios, thus identifying a pair of numbers with its quotient. In this unit, if they haven't already done so, students make the transition to blurring distinctions between ratio as pair and ratio as quotient. After an open-ended task intended to motivate the need for trigonometric ratios (although the term is not used), they examine side ratios of similar right triangles. They build tables of side ratios for several similar triangles, noting that quotients of corresponding sides are the same. Using their knowledge of similar triangles, they see that the ratios are the property of an angle rather than of a triangle. In section 3, students learn that, for right triangles, the ratios are called “sine,” “cosine,” and “tangent.” Students then examine the relationship between sine and cosine, and use their knowledge to solve problems. Later, students see the sine and cosine of an acute angle as the coordinates of a point on the unit circle formed by the terminal ray of the angle. They understand the radian measure of an angle as the arc subtended by the angle.F-TF.A.1 Using the unit circle, they extend the domains of the sine and cosine functions to all real numbers.F-TF.A.2 They make sense of the oscillations of sine and cosine, as well as the asymptotic behavior of tangent.

G.4.0 Pre-unit diagnostic assessment

Assess students’ ability to

• use the Pythagorean Theorem to find unknown lengths in right triangles;
• use properties of similar triangles to solve for an unknown side in similar right triangles.

After an open-ended task intended to motivate the need for trigonometric ratios (although the term is not used), students examine side ratios of similar right triangles. Students then build tables of side ratios for several similar triangles while noting that quotients of corresponding sides are the same. Using their knowledge of similar triangles they see that the ratios are a property of an angle rather than of a triangle. Only after laying this groundwork do students learn that, for right triangles, the ratios are called “sine,” “cosine,” and “tangent.” Finally, students examine the relationship between sine and cosine and use this knowledge to solve a variety of problems.

G.4.1 Why are trigonometric ratios useful?

Use side ratios of right triangles to solve a problem.

After an open-ended task intended to motivate the need for trigonometric ratios (although the term is not used), students examine side ratios of similar right triangles. Students then build tables of side ratios for several similar triangles while noting that quotients of corresponding sides are the same. Using their knowledge of similar triangles they see that the ratios are a property of an angle rather than of a triangle. Only after laying this groundwork do students learn that, for right triangles, the ratios are called “sine,” “cosine,” and “tangent.” Finally, students examine the relationship between sine and cosine and use this knowledge to solve a variety of problems.

G.4.2 Side ratios of similar triangles

Understand that, due to properties of similar triangles, side ratios in right triangles are properties of the angles in the triangle.

After an open-ended task intended to motivate the need for trigonometric ratios (although the term is not used), students examine side ratios of similar right triangles. Students then build tables of side ratios for several similar triangles while noting that quotients of corresponding sides are the same. Using their knowledge of similar triangles they see that the ratios are a property of an angle rather than of a triangle. Only after laying this groundwork do students learn that, for right triangles, the ratios are called “sine,” “cosine,” and “tangent.” Finally, students examine the relationship between sine and cosine and use this knowledge to solve a variety of problems.

G.4.3 Definitions of sine and cosine

Formalize their understanding of the ratio table by defining the trigonometric ratios.

After an open-ended task intended to motivate the need for trigonometric ratios (although the term is not used), students examine side ratios of similar right triangles. Students then build tables of side ratios for several similar triangles while noting that quotients of corresponding sides are the same. Using their knowledge of similar triangles they see that the ratios are a property of an angle rather than of a triangle. Only after laying this groundwork do students learn that, for right triangles, the ratios are called "sine," "cosine," and "tangent." Finally, students examine the relationship between sine and cosine and use this knowledge to solve a variety of problems.

Tasks

G-SRT Defining Trigonometric Ratios

G.4.4 Relationship of sine and cosine

Explain and use the relationship between sine and cosine in complementary angles.

After an open-ended task intended to motivate the need for trigonometric ratios (although the term is not used), students examine side ratios of similar right triangles. Students then build tables of side ratios for several similar triangles while noting that quotients of corresponding sides are the same. Using their knowledge of similar triangles they see that the ratios are a property of an angle rather than of a triangle. Only after laying this groundwork do students learn that, for right triangles, the ratios are called "sine," "cosine," and "tangent." Finally, students examine the relationship between sine and cosine and use this knowledge to solve a variety of problems.

Tasks

G-SRT Sine and Cosine of Complementary Angles
G-SRT Trigonometric Function Values

G.4.5 Solve problems using sine and cosine

Use sine, cosine, and tangent to solve right triangles in applied problems.

After an open-ended task intended to motivate the need for trigonometric ratios (although the term is not used), students examine side ratios of similar right triangles. Students then build tables of side ratios for several similar triangles while noting that quotients of corresponding sides are the same. Using their knowledge of similar triangles they see that the ratios are a property of an angle rather than of a triangle. Only after laying this groundwork do students learn that, for right triangles, the ratios are called “sine,” “cosine,” and “tangent.” Finally, students examine the relationship between sine and cosine and use this knowledge to solve a variety of problems.

Tasks

G-SRT, G-MG Seven Circles III

G.4.6 Summative assessment

Assess students' ability to

• use the relationship between sine and cosine to solve problems;
• use sine, cosine, and tangent to solve problems in right triangles (including indirect measurement).

After an open-ended task intended to motivate the need for trigonometric ratios (although the term is not used), students examine side ratios of similar right triangles. Students then build tables of side ratios for several similar triangles while noting that quotients of corresponding sides are the same. Using their knowledge of similar triangles they see that the ratios are a property of an angle rather than of a triangle. Only after laying this groundwork do students learn that, for right triangles, the ratios are called “sine,” “cosine,” and “tangent.” Finally, students examine the relationship between sine and cosine and use this knowledge to solve a variety of problems.

G.5 Measurement and Solid Geometry

• Use geometric shapes to describe objects and use measures of the shapes.
• Use coordinates to compute perimeters of polygons and areas of triangles and rectangles.
• Give arguments that combine dissection and informal limits to yield the circumference and area formulas for a circle.
• Give dissection arguments that yield the volume formula for prisms.
• Use the volume formula for prisms and an informal limit argument to obtain the volume formula for cylinders.
• Identify the shapes of two-dimensional cross-sections of three-dimensional objects.
• Identify three-dimensional objects generated from rotations of two-dimensional shapes.
• Obtain the formula for volume of a pyramid with square base via dissection.
• Use Cavalieri's Principle to obtain the formula for the volume of a pyramid from the formula for the volume of a pyramid with square base.
• Use volume formulas to solve problems.
• Solve volume problems involving the calculation of density.

In this unit students give more sophisticated, although still informal, arguments for the circumference, area, and volume formulas that they learned in earlier grades. These arguments rely on dissections, informal limits, and Cavalieri's Principle. After giving arguments for the volume formulas, students use these formulas in solving a variety of modeling problems, including problems that involve density.

Students have been reasoning with shapes and their attributes since first grade. In grade 5, they packed unit cubes into right rectangular prisms with whole-number length sides and showed that the product of the edge lengths gives the same result as counting the unit cubes. (5.MD.5a) In grade 7, students described the two-dimensional figures that result from slicing three-dimensional figures. (7.G.A.3) They gave an informal derivation of the relationship between the circumference and area of a circle, and used the resulting formula together with formulas for volumes of cubes and right prisms from earlier grades to solve problems. (7.G.B.4, 7.G.B.6) In grade 8, students learned the formulas for the volumes of cones, cylinders, and spheres, and used them to solve real-world and mathematical problems. (8.G.C.9)

G.5.0 Pre-unit diagnostic assessment

Assess students' ability to

• find the circumference of a circle from its area;
• find the volumes of various shapes including cylinders, cones,prisms;
• describe two-dimensional figures that result from slicing a right triangular prism.

In this unit students give more sophisticated, although still informal, arguments for the circumference, area, and volume formulas that they learned in earlier grades. These arguments rely on dissections, informal limits, and Cavalieri's Principle. After giving arguments for the volume formulas, students use these formulas in solving a variety of modeling problems, including problems that involve density.

G.5.1 Dimensions, surface area, and volume

Use volume formulas to solve real-life modeling problems.

In this unit students give more sophisticated, although still informal, arguments for the circumference, area, and volume formulas that they learned in earlier grades. These arguments rely on dissections, informal limits, and Cavalieri's Principle. After giving arguments for the volume formulas, students use these formulas in solving a variety of modeling problems, including problems that involve density.

G.5.2 Area and perimeter on the coordinate plane

Use coordinates to compute perimeters of polygons and areas of triangles and rectangles

In this unit students give more sophisticated, although still informal, arguments for the circumference, area, and volume formulas that they learned in earlier grades. These arguments rely on dissections, informal limits, and Cavalieri's Principle. After giving arguments for the volume formulas, students use these formulas in solving a variety of modeling problems, including problems that involve density.

Tasks

G-GPE Triangle Perimeters

G-GPE Squares on a coordinate grid

G.5.3 Informal arguments for circle circumference

Give arguments that combine dissection and informal limits to yield the circumference and area formulas for a circle.

In this unit students give more sophisticated, although still informal, arguments for the circumference, area, and volume formulas that they learned in earlier grades. These arguments rely on dissections, informal limits, and Cavalieri's Principle. After giving arguments for the volume formulas, students use these formulas in solving a variety of modeling problems, including problems that involve density.

Tasks

7.G Stained Glass

G.5.4 Informal arguments for volume formulas

• Give dissection arguments that yield the volume formula for prisms.
• Use the volume formula for prisms and an informal limit argument to obtain the volume formula for cylinders.
• Obtain the formula for volume of a pyramid with square base via dissection.

In this unit students give more sophisticated, although still informal, arguments for the circumference, area, and volume formulas that they learned in earlier grades. These arguments rely on dissections, informal limits, and Cavalieri's Principle. After giving arguments for the volume

formulas, students use these formulas in solving a variety of modeling problems, including problems that involve density.

Tasks

G-GMD Volume formulas for cylinders and prisms

G-GMD Volume of a Special Pyramid

G.5.5 Cross-sections, solids of revolution, and Cavalieri's Principle

• Identify two-dimensional cross-sections of three-dimensional objects.
• Identify three-dimensional objects generated from rotating two-dimensional shapes.
• Use Cavalieri's Principle to obtain the formula for the volume of a pyramid from the formula for the volume of a pyramid with square base.
• Use Cavalieri's Principle to obtain the formula for the volume of a cone.

In this unit students give more sophisticated, although still informal, arguments for the circumference, area, and volume formulas that they learned in earlier grades. These arguments rely on dissections, informal limits, and Cavalieri's Principle. After giving arguments for the volume formulas, students use these formulas in solving a variety of modeling problems, including problems that involve density.

Tasks

G-GMD, G-MG Tennis Balls in a Can

G-GMD Use Cavalieri's Principle to Compare Aquarium Volumes

G.5.6 Use volume formulas to solve problems

• Solve real-world and mathematical situations involving volume and surface area.
• Solve volume problems involving the calculation of density.

In this unit students give more sophisticated, although still informal, arguments for the circumference, area, and volume formulas that they learned in earlier grades. These arguments rely on dissections, informal limits, and Cavalieri's Principle. After giving arguments for the volume formulas, students use these formulas in solving a variety of modeling problems, including problems that involve density.

Tasks

G-GMD Doctor's Appointment
G-GMD Volume Estimation
G-MG Indiana Jones and the Golden Statue
G.MG Archimedes and the King's crown

G.5.7 Summative Assessment

Students demonstrate their ability to

• explain where formulas for the volume of various shapes come from;
• use volume to solve a real-world problem;
• sketch two-dimensional cross-sections of a rectangular prism;
• describe a three-dimensional shape generated by rotating a shape around a line.

In this unit students give more sophisticated, although still informal, arguments for the circumference, area, and volume formulas that they learned in earlier grades. These arguments rely on dissections, informal limits, and Cavalieri's Principle. After giving arguments for the volume formulas, students use these formulas in solving a variety of modeling problems, including problems that involve density.

G.6 Circles

• Use the Pythagorean Theorem to derive an equation for a circle of given center and radius.
• Use similarity to derive the fact that the length of the arc of a circle intercepted by an angle is proportional to the radius of the circle.
• Derive a formula for the area of a sector.
• Identify and describe relationships between central and inscribed angles and their arcs.
• Prove that an inscribed angle that subtends a diameter is a right angle, and its converse.
• Identify and describe relationships and ratios of lengths for intersecting chords.
• Prove that a radius and a tangent to a circle at the same point are perpendicular.
• Prove properties of angles of inscribed polygons.
• Use relationships about inscribed angles to solve problems about inscribed polygons.
• Use circles, cones, tangent segments, chords, and related figures, and their properties to describe objects.

Students begin this unit by working with circles on the coordinate plane and use the Pythagorean Theorem to derive the equation of a circle. They learn about radian measure and use similarity to derive the fact that the length of the arc intercepted by an angle is proportional to the radius of the circle. They develop a formula for the area of a sector of a circle and examine properties of central and inscribed angles in a circle along with their subtended arcs. Students also examine properties of tangent lines, radii, and intersecting chords and apply these properties to solve problems in a variety of contexts, including real-world situations.

In grade 4, students learned to view an angle as indicating an amount of “turn,” e.g., “An angle that turns through 1/360 of a circle is called a ‘one-degree angle,’ and can be used to measure angles.”4.MD.5 In unit G1, students established a precise definition for a circle, e.g., that a circle is the locus of all points at a given distance from a given point. They made straightedge and compass constructions of circles, perpendicular bisectors, angle bisectors, and midpoints. From unit G3, they know that all circles are similar and they have gained experience using triangle congruence criteria. In unit G4, students were introduced to right triangle trigonometry. Unit G5 concerned solid geometry, including one task (Use Cavalieri's Principle to Compare Aquarium Volumes) that involved working with a cross-section of a sphere. Students begin this unit by working with circles on the coordinate plane, and use the Pythagorean Theorem to derive the equation of a circle. They learn about radian measure and a formula for the area of a sector of a circle. They examine properties of central and inscribed angles in a circle, and their subtended arcs. Students examine properties of tangent lines and radii, and intersecting chords. They apply these properties in a variety of contexts, including real-world contexts. After this unit, students extend the domain of trigonometric functions to the unit circle in the coordinate plane, working with radian measure, and again making use of the Pythagorean Theorem.

G.6.0 Diagnostic pre-unit assessment

Diagnose students' ability to

- **find the area of a circle and of a sector of a circle;**
- **find measure of a sector angle when the sector partitions the circle into congruent pieces;**
- **construct a perpendicular bisector;**
- **find the distance between two given points on the coordinate plane.**

Students begin this unit by working with circles on the coordinate plane and use the Pythagorean Theorem to derive the equation of a circle. They learn about radian measure and use similarity to derive the fact that the length of the arc intercepted by an angle is proportional to the radius of the circle. They develop a formula for the area of a sector of a circle and examine properties of central and inscribed angles in a circle along with their subtended arcs. Students also examine properties of tangent lines, radii, and intersecting chords and apply these properties to solve problems in a variety of contexts, including real-world situations.

G.6.1 Equations of circles

Use the Pythagorean Theorem to derive a general equation for a circle of given center and radius.

Students begin this unit by working with circles on the coordinate plane and use the Pythagorean Theorem to derive the equation of a circle. They learn about radian measure and use similarity to derive the fact that the length of the arc intercepted by an angle is proportional to the radius of the circle. They develop a formula for the area of a sector of a circle and examine properties of central and inscribed angles in a circle along with their subtended arcs. Students also examine properties of tangent lines, radii, and intersecting chords and apply these properties to solve problems in a variety of contexts, including real-world situations.

Tasks

G-GPE Explaining the equation for a circle

G.6.2 Arc lengths, sectors, and radians

• Use similarity to derive the fact that length of an intercepted arc of an angle is proportional to the length of the radius of the circle.
• Define radian measure of an angle.
• Derive a formula for the area of a sector.
• Use the formula in solving problems.

Students begin this unit by working with circles on the coordinate plane and use the Pythagorean Theorem to derive the equation of a circle. They learn about radian measure and use similarity to derive the fact that the length of the arc intercepted by an angle is proportional to the radius of the circle. They develop a formula for the area of a sector of a circle and examine properties of central and inscribed angles in a circle along with their subtended arcs. Students also examine properties of tangent lines, radii, and intersecting chords and apply these properties to solve problems in a variety of contexts, including real-world situations.

Tasks

G-C Mutually Tangent Circles

G.6.3 Central and inscribed angles

• Identify and describe relationships between central and inscribed angles and their arcs.
• Prove that an inscribed angle that subtends a diameter is a right angle, and, conversely, that a right angle inscribed in a circle must subtend a diameter.
• Apply these relationships in various contexts.

Students begin this unit by working with circles on the coordinate plane and use the Pythagorean Theorem to derive the equation of a circle. They learn about radian measure and use similarity to derive the fact that the length of the arc intercepted by an angle is proportional to the radius of the circle. They develop a formula for the area of a sector of a circle and examine properties of central and inscribed angles in a circle along with their subtended arcs. Students also examine properties of tangent lines, radii, and intersecting chords and apply these properties to solve problems in a variety of contexts, including real-world situations.

Tasks

G-C Orbiting Satellite
G-C Right triangles inscribed in circles I
G-C Right triangles inscribed in circles II

G.6.4 Mid-Unit Assessment

Assess students' ability to

• solve area problems involving sectors;
• use properties of central angles and inscribed angles to find arc length.

Students begin this unit by working with circles on the coordinate plane and use the Pythagorean Theorem to derive the equation of a circle. They learn about radian measure and use similarity to derive the fact that the length of the arc intercepted by an angle is proportional to the radius of the circle. They develop a formula for the area of a sector of a circle and examine properties of central and inscribed angles in a circle along with their subtended arcs. Students also examine properties of tangent lines, radii, and intersecting chords and apply these properties to solve problems in a variety of contexts, including real-world situations.

G.6.5 Radii, tangent lines, chords, and secants

• Prove that a radius and a tangent line that intersect at the same point are perpendicular.
• Identify and describe relationships and ratios of lengths for intersecting chords.

Students begin this unit by working with circles on the coordinate plane and use the Pythagorean Theorem to derive the equation of a circle. They learn about radian measure and use similarity to derive the fact that the length of the arc intercepted by an angle is proportional to the radius of the circle. They develop a formula for the area of a sector of a circle and examine properties of central and inscribed angles in a circle along with their subtended arcs. Students also examine properties of tangent lines, radii, and intersecting chords and apply these properties to solve problems in a variety of contexts, including real-world situations.

Tasks

G-C, G-CO Tangent Lines and the Radius of a Circle
G-C, G-SRT Neglecting the Curvature of the Earth
G-C Tangent to a circle from a point

G.6.6 Inscribed and circumscribed polygons

• Prove that the opposite angles in a cyclic quadrilateral that contains the center of the circle are supplementary.
• Construct the inscribed and circumscribed circles of a triangle.

Students begin this unit by working with circles on the coordinate plane and use the Pythagorean Theorem to derive the equation of a circle. They learn about radian measure and use similarity to derive the fact that the length of the arc intercepted by an angle is proportional to the radius of the circle. They develop a formula for the area of a sector of a circle and examine properties of central and inscribed angles in a circle along with their subtended arcs. Students also examine properties of tangent lines, radii, and intersecting chords and apply these properties to solve problems in a variety of contexts, including real-world situations.

Tasks

G-C Opposite Angles in a Cyclic Quadrilateral
G-C Inscribing a triangle in a circle
G.C Inscribing a circle in a triangle I

G.6.7 Applications

Use circles, cones, tangent segments, chords, and related figures, and their properties to describe objects.

Students begin this unit by working with circles on the coordinate plane and use the Pythagorean Theorem to derive the equation of a circle. They learn about radian measure and use similarity to derive the fact that the length of the arc intercepted by an angle is proportional to the radius of the circle. They develop a formula for the area of a sector of a circle and examine properties of central and inscribed angles in a circle along with their subtended arcs. Students also examine properties of tangent lines, radii, and intersecting chords and apply these properties to solve problems in a variety of contexts, including real-world situations.

Tasks

G-MG Satellite
G-MG The Lighthouse Problem
G-MG Ice Cream Cone
G-C Two Wheels and a Belt

G.6.8 Summative Assessment

Assess students' ability to apply knowledge of circle properties.

Students begin this unit by working with circles on the coordinate plane and use the Pythagorean Theorem to derive the equation of a circle. They learn about radian measure and use similarity to derive the fact that the length of the arc intercepted by an angle is proportional to the radius of the circle. They develop a formula for the area of a sector of a circle and examine properties of central and inscribed angles in a circle along with their subtended arcs. Students also examine properties of tangent lines, radii, and intersecting chords and apply these properties to solve problems in a variety of contexts, including real-world situations.