Geometry Pacing Guide

Vision Statement

Imagine a classroom, a school, or a school district where all students have access to high-quality, engaging mathematics instruction. There are ambitious expectations for all, with accommodation for those who need it. Knowledgeable teachers have adequate resources to support their work and are continually growing as professionals. The curriculum is mathematically rich, offering students opportunities to learn important mathematical concepts and procedures with understanding. Technology is an essential component of the environment. Students confidently engage in complex mathematical tasks chosen carefully by teachers. They draw on knowledge from a wide variety of mathematical topics, sometimes approaching the same problem from different mathematical perspectives or representing the mathematics in different ways until they find methods that enable them to make progress. Teachers help students make, refine, and explore conjectures on the basis of evidence and use a variety of reasoning and proof techniques to confirm or disprove those conjectures. Students are flexible and resourceful problem solvers. Alone or in groups and with access to technology, they work productively and reflectively, with the skilled guidance of their teachers. Orally and in writing, students communicate their ideas and results effectively. They value mathematics and engage actively in learning it.

National Council of Teachers of Mathematics

Geometry
Quarterly Overview Sheet

1st Quarter

Triangles

G.8 The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse. (C3)

Reasoning, Lines, and Transformations

G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include
- a) investigating and using formulas for finding distance, midpoint, and slope; (C3)
- b) applying slope to verify and determine whether lines are parallel or perpendicular; (C4)

(review vocabulary)

G.1 The student will construct and judge the validity of a logical argument consisting of a set of premises and a conclusion. This will include
- a) identifying the converse, inverse, and contrapositive of a conditional statement; (A1)
- b) translating a short verbal argument into symbolic form; (C3)
- c) using Venn diagrams to represent set relationships; and (B2)
- d) using deductive reasoning. (C6)

G.4 The student will construct and justify the constructions of
- a) a line segment congruent to a given line segment; (C3)
- b) the perpendicular bisector of a line segment; (C3)
- c) a perpendicular to a given line from a point not on the line; (C3)
- d) a perpendicular to a given line at a given point on the line; (C3)
- e) the bisector of a given angle, (C3)
- f) an angle congruent to a given angle; and (C3)
- g) a line parallel to a given line through a point not on the given

2nd Quarter

G.2 The student will use the relationships between angles formed by two lines cut by a transversal to
- a) determine whether two lines are parallel; (A5)
- b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and (C6)
- c) solve real-world problems involving angles formed when parallel lines are cut by a transversal. (A5)

Triangles

G.6 The student, given information in the form of a figure or statement, will prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs. (C6)

G.7 The student, given information in the form of a figure or statement, will prove two triangles are similar, using algebraic and coordinate methods as well as deductive proofs. (C6)

G.5 The student, given information concerning the lengths of sides and/or measures of angles in triangles, will
- a) order the sides by length, given the angle measures; (A3)
- b) order the angles by degree measure, given the side lengths; (A3)
- c) determine whether a triangle exists; and (A3)
- d) determine the range in which the length of the third side must lie. (A3)

These concepts will be considered in the context of real-world situations.

G.8 The student will solve real-world problems involving right triangles by using the properties of special right triangles, and right triangle trigonometry. (C3)

3rd Quarter

Polygons and Circles

G.9 The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems. (C4)

Reasoning, Lines, and Transformations

G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include
- c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and (C3)
- d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods. (C3)

Polygons and Circles

G.10 The student will solve real-world problems involving angles of polygons. (C3)

G.11 The student will use angles, arcs, chords, tangents, and secants to
- a) investigate, verify, and apply properties of circles; (C3)
- b) solve real-world problems involving properties of circles; and (C3)
- c) find arc lengths and areas of sectors in circles. (C3)

4th Quarter

G.12 The student, given the coordinates of the center of a circle and a point on the circle, will write the equation of the circle. (C3)

Three-Dimensional Figures

G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems. (C3)

G.14 The student will use similar geometric objects in two- or three-dimensions to
- a) compare ratios between side lengths, perimeters, areas, and volumes; (C3)
- b) determine how changes in one or more dimensions of an object affect area and/or volume of the object; (C3)
- c) determine how changes in area and/or volume of an object affect one or more dimensions of the object; and (C3)
- d) solve real-world problems about similar geometric objects. (C3)

line. (C3)			

1st Quarter

Unit: Triangles

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.8

The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Determine whether a triangle formed with three given lengths is a right triangle.		• The Pythagorean Theorem is essential for solving problems involving right triangles. • Many historical and algebraic proofs of the Pythagorean Theorem exist. • The relationships between the sides and angles of right triangles are useful in many applied fields. • Some practical problems can be solved by choosing an efficient representation of the problem.	Smart Lesson TEI Smart Lesson TEI 2

Unit: Reasoning, lines, and transformations

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.3

The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include

a) investigating and using formulas for finding distance, midpoint, and slope;
b) applying slope to verify and determine whether lines are parallel or perpendicular;

Essential Knowledge and Skills **Essential Vocabulary:**	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Find the coordinates of the midpoint of a segment, using the midpoint formula. • Use a formula to find the slope of a line. • Compare the slopes to determine whether two lines are parallel, perpendicular, or neither. • Apply the distance formula to find the length of a line segment when given the coordinates of the endpoints.		• The distance formula is an application of the Pythagorean Theorem. • Geometric figures can be represented in the coordinate plane. • Techniques for investigating symmetry may include paper folding, coordinate methods, and dynamic geometry software. • Parallel lines have the same slope. • The product of the slopes of perpendicular lines is -1.	Smart Lesson TEI

Unit: Reasoning, lines, and transformations

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.1

The student will construct and judge the validity of a logical argument consisting of a set of premises and a conclusion. This will include

a) identifying the converse, inverse, and contrapositive of a conditional statement;
b) translating a short verbal argument into symbolic form;
c) using Venn diagrams to represent set relationships; and
d) using deductive reasoning.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Identify the converse, inverse, and contrapositive of a conditional statement. • Translate verbal arguments into symbolic form, such as $(p \rightarrow q)$ and $(\sim p \rightarrow \sim q)$. • Determine the validity of a logical argument. • Use valid forms of deductive reasoning, including the law of syllogism, the law of the contrapositive, the law of detachment, and counterexamples. • Select and use various types of reasoning and methods of proof, as appropriate. • Use Venn diagrams to represent set relationships, such as intersection and union. • Interpret Venn diagrams. • Recognize and use the symbols of formal logic, which include $\rightarrow$, $\leftrightarrow$, $\sim$, $\therefore$, $\wedge$, and $\vee$.		• Inductive reasoning, deductive reasoning, and proof are critical in establishing general claims. • Deductive reasoning is the method that uses logic to draw conclusions based on definitions, postulates, and theorems. • Inductive reasoning is the method of drawing conclusions from a limited set of observations. • Proof is a justification that is logically valid and based on initial	

		assumptions, definitions, postulates, and theorems. • Logical arguments consist of a set of premises or hypotheses and a conclusion. • Euclidean geometry is an axiomatic system based on undefined terms (point, line and plane), postulates, and theorems. • When a conditional and its converse are true, the statements can be written as a biconditional, i.e., *iff* or *if and only if*. • Logical arguments that are valid may not be true. Truth and validity are not synonymous.	

Unit: Reasoning, lines, and transformations

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.2

The student will use the relationships between angles formed by two lines cut by a transversal to

a) determine whether two lines are parallel;
b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and
c) solve real-world problems involving angles formed when parallel lines are cut by a transversal.

Essential Knowledge and Skills **Essential Vocabulary:**	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Use algebraic and coordinate methods as well as deductive proofs to verify whether two lines are parallel. • Solve problems by using the relationships between pairs of angles formed by the intersection of two parallel lines and a transversal including corresponding angles, alternate interior angles, alternate exterior angles, and same-side (consecutive) interior angles. • Solve real-world problems involving intersecting and parallel lines in a plane.		• Parallel lines intersected by a transversal form angles with specific relationships. • Some angle relationships may be used when proving two lines intersected by a transversal are parallel. • The Parallel Postulate differentiates Euclidean from non-Euclidean geometries such as spherical geometry and hyperbolic geometry.	

2nd Quarter

Unit: Reasoning, lines, and transformations

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.4

The student will construct and justify the constructions of

a) a line segment congruent to a given line segment;
b) the perpendicular bisector of a line segment;
c) a perpendicular to a given line from a point not on the line;
d) a perpendicular to a given line at a given point on the line;
e) the bisector of a given angle;
f) an angle congruent to a given angle; and
g) a line parallel to a given line through a point not on the given line.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Construct and justify the constructions of – a line segment congruent to a given line segment; – the perpendicular bisector of a line segment; – a perpendicular to a given line from a point not on the line; – a perpendicular to a given line at a point on the line; – the bisector of a given angle; – an angle congruent to a given angle; and – a line parallel to a given line through a point not on the given line. • Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.† • Construct the inscribed and circumscribed circles of a triangle.† • Construct a tangent line from a point outside a given circle to the circle.† †Revised March 2011		• Construction techniques are used to solve real-world problems in engineering, architectural design, and building construction. • Construction techniques include using a straightedge and compass, paper folding, and dynamic geometry software.	

Unit: Triangles

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.6

The student, given information in the form of a figure or statement, will prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Use definitions, postulates, and theorems to prove triangles congruent. • Use coordinate methods, such as the distance formula and the slope formula, to prove two triangles are congruent. • Use algebraic methods to prove two triangles are congruent.		• Congruence has real-world applications in a variety of areas, including art, architecture, and the sciences. • Congruence does not depend on the position of the triangle. • Concepts of logic can demonstrate congruence or similarity. • Congruent figures are also similar, but similar figures are not necessarily congruent.	Smart Lesson TEI

Unit: Triangles

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.7

The student, given information in the form of a figure or statement, will prove two triangles are similar, using algebraic and coordinate methods as well as deductive proofs.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Use definitions, postulates, and theorems to prove triangles similar. • Use algebraic methods to prove that triangles are similar. • Use coordinate methods, such as the distance formula, to prove two triangles are similar.		• Similarity has real-world applications in a variety of areas, including art, architecture, and the sciences. • Similarity does not depend on the position of the triangle. • Congruent figures are also similar, but similar figures are not necessarily congruent.	Smart Lesson TEI

Unit: Triangles

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.5

The student, given information concerning the lengths of sides and/or measures of angles in triangles, will

a) order the sides by length, given the angle measures;
b) order the angles by degree measure, given the side lengths;
c) determine whether a triangle exists; and
d) determine the range in which the length of the third side must lie.

These concepts will be considered in the context of real-world situations.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Order the sides of a triangle by their lengths when given the measures of the angles. • Order the angles of a triangle by their measures when given the lengths of the sides. • Given the lengths of three segments, determine whether a triangle could be formed. • Given the lengths of two sides of a triangle, determine the range in which the length of the third side must lie. • Solve real-world problems given information about the lengths of sides and/or measures of angles in triangles.		• The longest side of a triangle is opposite the largest angle of the triangle and the shortest side is opposite the smallest angle. • In a triangle, the length of two sides and the included angle determine the length of the side opposite the angle. • In order for a triangle to exist, the length of each side must be within a range that is determined by the lengths of the other two sides.	Smart Lesson TEI

Unit: Triangles

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.8

The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Determine whether a triangle formed with three given lengths is a right triangle. • Solve for missing lengths in geometric figures, using properties of 45°-45°-90° triangles. • Solve for missing lengths in geometric figures, using properties of 30°-60°-90° triangles. • Solve problems involving right triangles, using sine, cosine, and tangent ratios. • Solve real-world problems, using right triangle trigonometry and properties of right triangles. • Explain and use the relationship between the sine and cosine of complementary angles.† †**Revised March 2011**		• The relationships between the sides and angles of right triangles are useful in many applied fields. • Some practical problems can be solved by choosing an efficient representation of the problem. • Another formula for the area of a triangle is $A = \frac{1}{2}ab\sin C$. • The ratios of side lengths in similar right triangles (adjacent/hypotenuse or opposite/hypotenuse) are independent of the scale factor and depend only on the angle the	Smart Lesson TEI

		hypotenuse makes with the adjacent side, thus justifying the definition and calculation of trigonometric functions using the ratios of side lengths for similar right triangles.	

3rd Quarter

Unit: Polygons and Circles

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.9

The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Solve problems, including real-world problems, using the properties specific to parallelograms, rectangles, rhombi, squares, isosceles trapezoids, and trapezoids. • Prove that quadrilaterals have specific properties, using coordinate and algebraic methods, such as the distance formula, slope, and midpoint formula. • Prove the characteristics of quadrilaterals, using deductive reasoning, algebraic, and coordinate methods. • Prove properties of angles for a quadrilateral inscribed in a circle.† †**Revised March 2011**		• The terms characteristics and properties can be used interchangeably to describe quadrilaterals. The term characteristics is used in elementary and middle school mathematics. • Quadrilaterals have a hierarchical nature based on the relationships between their sides, angles, and diagonals. • Characteristics of quadrilaterals can be used to identify the quadrilateral and to find the measures of sides and angles.	

Unit: Reasoning, lines, and transformations

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.3

The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include

c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and
d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Determine whether a figure has point symmetry, line symmetry, both, or neither. • Given an image and preimage, identify the transformation that has taken place as a reflection, rotation, dilation, or translation. • Apply the distance formula to find the length of a line segment when given the coordinates of the endpoints.		• Transformations and combinations of transformations can be used to describe movement of objects in a plane. • Geometric figures can be represented in the coordinate plane. • Techniques for investigating symmetry may include paper folding, coordinate methods, and dynamic geometry software. • The image of an object or function graph after an isomorphic transformation is congruent to the preimage of the object.	

Unit: Polygon and Circles

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.10

The student will solve real-world problems involving angles of polygons.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Solve real-world problems involving the measures of interior and exterior angles of polygons. • Identify tessellations in art, construction, and nature. • Find the sum of the measures of the interior and exterior angles of a convex polygon. • Find the measure of each interior and exterior angle of a regular polygon. • Find the number of sides of a regular polygon, given the measures of interior or exterior angles of the polygon.		• A regular polygon will tessellate the plane if the measure of an interior angle is a factor of 360. • Both regular and nonregular polygons can tessellate the plane. • Two intersecting lines form angles with specific relationships. • An exterior angle is formed by extending a side of a polygon. • The exterior angle and the corresponding interior angle form a linear pair. • The sum of the measures of the interior angles of a convex polygon may be found by dividing the interior of the polygon into nonoverlapping triangles.	

Unit: Polygon and Circles

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.11

The student will use angles, arcs, chords, tangents, and secants to

a) investigate, verify, and apply properties of circles;
b) solve real-world problems involving properties of circles; and
c) find arc lengths and areas of sectors in circles.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Find lengths, angle measures, and arc measures associated with – two intersecting chords; – two intersecting secants; – an intersecting secant and tangent; – two intersecting tangents; and – central and inscribed angles. • Calculate the area of a sector and the length of an arc of a circle, using proportions. • Solve real-world problems associated with circles, using properties of angles, lines, and arcs. • Verify properties of circles, using deductive reasoning, algebraic, and coordinate methods.		• Many relationships exist between and among angles, arcs, secants, chords, and tangents of a circle. • All circles are similar. • A chord is part of a secant. • Real-world applications may be drawn from architecture, art, and construction.	Smart Lesson TEI Smart Lesson TEI 2

Unit: Polygons and Circles

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.12

The student, given the coordinates of the center of a circle and a point on the circle, will write the equation of the circle.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Identify the center, radius, and diameter of a circle from a given standard equation. • Use the distance formula to find the radius of a circle. • Given the coordinates of the center and radius of the circle, identify a point on the circle. • Given the equation of a circle in standard form, identify the coordinates of the center and find the radius of the circle. • Given the coordinates of the endpoints of a diameter, find the equation of the circle. • Given the coordinates of the center and a point on the circle, find the equation of the circle. • Recognize that the equation of a circle of given center and radius is derived using the Pythagorean Theorem.† †**Revised March 2011**		• A circle is a locus of points equidistant from a given point, the center. • Standard form for the equation of a circle is $(x-h)^2+(y-k)^2=r^2$, where the coordinates of the center of the circle are (h,k) and r is the length of the radius. • The circle is a conic section.	

Unit: Three-Dimensional Figures

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.13

The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Find the total surface area of cylinders, prisms, pyramids, cones, and spheres, using the appropriate formulas. • Calculate the volume of cylinders, prisms, pyramids, cones, and spheres, using the appropriate formulas. • Solve problems, including real-world problems, involving total surface area and volume of cylinders, prisms, pyramids, cones, and spheres as well as combinations of three-dimensional figures. Calculators may be used to find decimal approximations for results.		• The surface area of a three-dimensional object is the sum of the areas of all its faces. • The volume of a three-dimensional object is the number of unit cubes that would fill the object.	Smart Lesson TEI

Unit: Three-Dimensional Figures

Process standards: The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations.

G.14

The student will use similar geometric objects in two- or three-dimensions to

a) compare ratios between side lengths, perimeters, areas, and volumes;
b) determine how changes in one or more dimensions of an object affect area and/or volume of the object;
c) determine how changes in area and/or volume of an object affect one or more dimensions of the object; and
d) solve real-world problems about similar geometric objects.

Essential Knowledge and Skills *Essential Vocabulary:*	**Essential Questions**	**Essential Understandings All Students should…**	**Tasks/ Recommended Activities**
• Compare ratios between side lengths, perimeters, areas, and volumes, given two similar figures. • Describe how changes in one or more dimensions affect other derived measures (perimeter, area, total surface area, and volume) of an object. • Describe how changes in one or more measures (perimeter, area, total surface area, and volume) affect other measures of an object. • Solve real-world problems involving measured attributes of similar objects.		• A change in one dimension of an object results in predictable changes in area and/or volume. • A constant ratio exists between corresponding lengths of sides of similar figures. • Proportional reasoning is integral to comparing attribute measures in similar objects.	