NEW PROVIDENCE BOARD OF EDUCATION

Administrative Offices
356 Elkwood Avenue
New Providence, New Jersey 07974

GEOMETRY

Curriculum Guide

Grades 10-11

2009

Board Approved: August 27, 2009

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NEW JERSEY CORE CURRICULUM CONTENT STANDARDS

Mathematics

- 4.1 (Number and Numerical Operations) All students will develop number sense and will perform standard numerical operations and estimations on all types of numbers in a variety of ways.

- 4.2 (Geometry and Measurement) All students will develop spatial sense and the ability to use geometric properties, relationships, and measurement to model, describe and analyze phenomena.

- 4.3 (Patterns and Algebra) All students will represent and analyze relationships among variable quantities and solve problems involving patterns, functions, and algebraic concepts and processes.

- 4.4 (Data analysis, probability, and discrete mathematics) All students will develop an understanding of the concepts and techniques of data analysis, probability, and discrete mathematics, and will use them to model situations, solve problems, and analyze and draw appropriate inferences from data.

- 4.5 (Mathematical processes) All students will use mathematical processes of problem-solving, communication, connections, reasoning, representations, and technology to solve problems and communicate mathematical ideas.

Language Arts Literacy

- 3.1 (Reading) All students will understand and apply the knowledge of sounds, letters, and word in written English to become independent and fluent readers, and will read a variety of materials and texts with fluency and comprehension.

- 3.2 (Writing) All students will write in clear, concise, organized language that varies in content and form for different audiences and purposes.

- 3.3 (Speaking) All students will speak in clear, concise, organized language that varies in content and form for different audiences and purposes.

- 3.4 (Listening) All students will listen actively to Information from a variety of sources in a variety of situations.

- 3.5 (Viewing and Media Literacy) All students will access, view, evaluate, and respond to print, nonprint, and electronic texts and resources.

Technology

- 8.1(Educational Technology) All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaboratively and to create and communicate knowledge.

- 8.2 (Technology Education, Engineering and Design) All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world as they relate to the individual, global society, and the environment.

21st Century Life and Careers

- 9.1 (21st Century Life Skills) All students will demonstrate creative, critical thinking, collaboration and problem solving skills to function successfully as global citizens and workers in diverse ethnic and organizational cultures.

- 9.2 (Personal Financial Literacy) All students will develop skills and strategies that promote personal and financial responsibility related to financial planning, savings, investment, and charitable giving in the global economy.

COURSE DESCRIPTION

Geometry is the second course in a sequence of college-preparatory mathematics courses. It follows the course of Algebra I, taken in grade 8 or grade 9. The course is designed to build a strong foundation in basic geometric skills and concepts, including the exploration of two-dimensional and three-dimensional figures. Upon completion, students will be prepared to take the next course, Intermediate Algebra and Trigonometry.

In addition to content-based knowledge and skills, this curriculum integrates the skills, knowledge, and expertise of 21st Century Learning as identified by the Partnership for 21st Century Skills. Twenty-first Century Learning, when used in combination with standards-based content, ensures that students are prepared for success in today's challenging environment. In this course, students will solve challenging, authentic problems utilizing technology to explore their options and designs. Students will move beyond a basic competency in mathematics to a better understanding of the content at a higher level by weaving interdisciplinary and global themes into the course. This includes, but is not limited to, economic, financial, business, civic, and health literacy. Students will develop innovative skills to prepare them for the complex life and work environments of the 21st century. Students will exhibit a wide range of problem-solving and critical thinking skills to better assess the abundance of information and rapid changes in the technology of our world.

Written by: Karen Gartner

Department Head: Shelly Phillips

ADOPTED TEXT(S)

McDougal Littell Geometry – by Ron Larson, Laurie Boswell, and Lee Stiff
McDougal Littell Inc.

ADDITIONAL RESOURCES

- Leveled Textbook
- Chapter Resource Books
- Practice Workbook – leveled practice
- Basic Skills Workbook
- Notetaking Guide
- Worked-Out Solution Key
- Standardized Test Practice Workbook
- Test and Practice Generator
- CD-ROM for electronic teacher tools
- Electronic lesson presentations
- Daily Homework Quizzes
- Companion website for students at www.classzone.com
- Safari Montage for videos
- www.Quia.com for activities, online games, and independent assessments
- Other websites: www.howstuffworks.com
- Models of solid geometric shapes and their two-dimensional nets
- Compasses, protractors, rulers

Unit 1: Basic Geometric Ideas

Suggested Time Frame: 8 – 10 weeks

I. DESIRED RESULTS

Subject/Topic Areas:

Patterns and reasoning
Points, lines, planes
Angles and their measures
Reasoning and proof
Parallel lines and transversals
Perpendicular lines

Critical Vocabulary:

Conjecture	Opposite rays	Congruent angles
Inductive reasoning	Compass	Counterexample
Deductive reasoning	Segment	Postulate
Midpoint formula	Endpoints	Ray
Bisector	Collinear	Initial point
Distance formula	Adjacent angles	Vertical angles
Biconditional statement	Complement	Supplement
Linear pair	Negation	Perpendicular
Conditional statement	If-then form	Hypothesis
Conclusion	Converse	Inverse
Contrapositive	Theorem	Parallel
Law of syllogism	Law of detachment	Transversal
Alternate interior angles	Alternate exterior angles	Corresponding angles
Same side interior angles	Flow proof	Skew lines

I. DESIRED RESULTS (CONT.)

Established Goals– NJCCCS
(Including content area(s), technology, and life-skill standards/indicators)

Mathematics

- 4.2 (Geometry and Measurement) All students will develop spatial sense and the ability to use geometric properties, relationships, and measurement to model, describe and analyze phenomena.

- 4.3 (Patterns and Algebra) All students will represent and analyze relationships among variable quantities and solve problems involving patterns, functions, and algebraic concepts and processes.

- 4.5 (Mathematical Processes) All students will use mathematical processes of problem-solving, communication, connections, reasoning, representations, and technology to solve problems and communicate mathematical ideas.

Language Arts Literacy

- 3.1 (Reading) All students will understand and apply the knowledge of sounds, letters, and word in written English to become independent and fluent readers, and will read a variety of materials and texts with fluency and comprehension.

- 3.2 (Writing) All students will write in clear, concise, organized language that varies in content and form for different audiences and purposes.

- 3.3 (Speaking) All students will speak in clear, concise, organized language that varies in content and form for different audiences and purposes.

- 3.4 (Listening) All students will listen actively to Information from a variety of sources in a variety of situations.

- 3.5 (Viewing and Media Literacy) All students will access, view, evaluate, and respond to print, nonprint, and electronic texts and resources.

Technological Literacy

- 8.1 (Computer and Information Literacy) All students will use computer applications to gather and organize information and to solve problems.

- 8.2 (Technology Education) All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world as they relate to the individual, society, and their environment.

Career Education and Consumer, Family, and Life Skills

- 9.1 (Career and Technical Education) All students will develop career awareness and planning, employability skills, and foundational knowledge necessary for success in the workplace.

- 9.2 (Consumer, Family, and Life Skills) All students will demonstrate critical life skills in order to be functional members of society.

Enduring Understandings: Students should understand that:	**Essential Questions:**
Geometric figures can be used to represent real-world situations. Logical reasoning is used to draw conclusions from organized data. Slopes of lines determine their relative steepness. "Solving" and "proving" are different concepts. Lines and angles can be described, classified, and analyzed by their attributes.	How are solving and proving different? What does it take to verify a conjecture? Why do we classify geometric objects? How does precise language help us express mathematical ideas? How can conclusions be drawn based on observed patterns? What are the benefits in drawing conclusions based on patterns?

Students Will Know and Be Able To:

- Find and describe patterns.
- Use inductive reasoning to make real-world conjectures.
- Sketch the intersections of lines and planes.
- Use the Midpoint Formula and Distance Formula.
- Classify angles by size.
- Bisect angles and line segments.
- Classify angle pairs with appropriate vocabulary terms.
- Analyze conditional statements and write postulates about basic geometric shapes.
- Recognize and use definitions and biconditional statements.
- Form conclusions based upon the laws of logic.
- Use symbolic notation to represent logical statements.
- Prove properties about special pairs of angles.
- Identify angles formed by transversals.
- Write different types of proofs involving parallel and perpendicular lines.
- Construct parallel lines and perpendicular lines using a compass and straightedge.
- Write equations of parallel and perpendicular lines.

II. EVIDENCE OF STUDENT LEARNING

Formative Performance Task (A Formative Performance Task is presented to students at the beginning of the unit. It presents a problem that drives learning and may include several graded assessments.).	**Summative Performance Task** (A Summative Performance Task is a *timed and graded test that assesses student learning*. It is generally a post-assessment administered at the end of a unit of study.)
As a website designer, you have been asked to construct a new logo for a company involved in packaging fragrances. The company wants a fresh geometric design that would appeal to all ages. For the first design, use a compass, protractor, and ruler. Then show the client an improved design using computer software. Use geometric terms to describe the integral parts of the logo.* As a cartographer, you have been commissioned to create the road system of a model city. The city founders have requested parallel and perpendicular streets for easy maneuverability. Investigate the city of Philadelphia and use it to design the streets of the new city.*	Find a radio or television commercial in which a conditional statement is used or implied. Write the words of the commercial as a script. Then summarize the commercial as a single conditional statement. Analyze its validity. Develop other forms of conditional statements, like its converse or inverse. Draw a Venn diagram to show further interpretation of the statement. Can you find a counterexample? Explain the game of pocket billiards, or pool, in relationship to the angles made as the ball bounces off the table's cushion. Use detailed examples to describe the geometric theorems at work.

Additional Graded/Formal Evidence of Student Learning and Progress

- Tests on describing patterns; writing conditional statements; proving lines parallel or perpendicular; solving angle puzzles involving parallel lines and transversals
- Readings: novel entitled Flatland; Euclid's Elements
- Essays: How is geometry used by construction workers? Where is geometry found in nature? Why can't inductive reasoning be used to prove a statement true?
- Presentations: Present several works by M. C. Escher (or Frank Lloyd Wright, I. M. Pei, Buckminster Fuller, etc.) and present the geometry used.
- Other: Use Geometer's Sketchpad to copy a palace or other famous architectural design. Identify as many geometric shapes as you can, both plane and solid.

Informal Assessments

(Informal assessments that allow students and teachers to check for understanding and monitor progress.)

- Pre-Assessments on inductive and deductive reasoning; writing linear equations for parallel and perpendicular lines; finding terms of a sequence
- Portfolios: Have students collect their best two-column proof, paragraph proof, and flow proof for their portfolio
- Journals: Describe the use of parallel and perpendicular line segments in the creation of a drawing showing two-point perspective
- Checklists: Provide a checklist of geometric symbols from the unit. Have students identify and write an example for each.
- Peer Review
- Informal Observations and Dialogues: Discuss how a pair of scissors can depict vertical angles. How does a plumb line help you hang wallpaper?
- Think-Alouds: How is using the midpoint formula similar to finding the average of two numbers? How can you design a protractor with 360 degrees?
- Examinations of Student Work
- Other

III. LEARNING PLAN

Suggested Activities	Strategies for Differentiation
(Suggested learning activities that will allow students to successfully complete the assessment activities described in Section II).	*(Differentiating content, process, and/or product, using variables of student readiness, interest, and learning style).* *Examples include:* *Readiness: small-group instruction, homework options, tiered assessments, compacting, multiple-entry points.* *Interest: Choices of books, homework options, explorations by interest and modes of expression (artistic, technological, written, oral, community service).* *Learning Style: Organizational options, working choice options, flexible environment, Multiple Intelligences options*
Have students investigate figurate numbers like square, triangular, pentagonal, and hexagonal numbers. Use dots to represent each term of the sequence. Demonstrate how two triangular numbers form a square number. Link geometry to astronomy with the study of constellations and their historical backgrounds. Have students describe their favorite constellation by using as many geometric terms from the unit as possible. Have students use Geometer's Sketchpad to construct parallel lines and discover the relationships among corresponding angles, vertical angles, alternate interior angles, same-side angles, and alternate exterior angles. Will the converses of those statements be true?* Some diamonds sparkle more than others because of the way they are cut. The amount of brilliance depends on the angle of the diamond's faces, how they catch and reflect light. Thanks to the work of the Polish mathematician Tolkowsky, gem cutters know the exact angles to cut the faces of diamonds to produce many different levels of brilliance. Invite a jeweler to class to speak about these angles. Surveyors use transits and sailors use sextants to measure angles important in their careers. Have students explore these devices and report to the class. Use the Internet to show photographs of the devices.* Students struggle with proofs because they can not decide what information is needed in the proof. Have students think of a proof as a series of conditional statements strung together.	Tiered textbook assignments offer differentiation on many levels. Individualize video clips from safari.npsd.us.* Students with fine motor difficulties may have problems using a protractor. Have students work in pairs so they can assist each other in measuring and creating specific angles. Challenge students to read Alice In Wonderland and write about how Lewis Carroll uses reasoning in his writings. Kinesthetic learners will enjoy paper-folding constructions to find angle bisectors, midpoints of segments, and perpendicular bisectors. Encourage the use of a protractor and ruler to check their final works. Have visual learners use highlighters or colored pencils to mark the transversal in diagrams of parallel lines. This helps students to focus on finding specific angle pairs. Challenge students to determine the negation of statements that use the quantifiers "all" or "none." For example, the negation of the statement,"All math students are geniuses." would be "Not all math students are geniuses." or "Some math students are not geniuses."

Encourage the use of Inspiration software to display that flow. Several types of graphic organizers are available in the program.* Bring in a set of blueprints for a house or a building. Ask students what blueprints are used for and explain how they can be used to solve problems in construction before the actual building begins.	Have golf enthusiasts explain the meaning of the loft of a golf club. (It is the measure of the angle that the head of the club would form with a vertical ray. Golf clubs of the same type are numbered so that greater numbers indicate greater amounts of loft.) How does the loft of a club affect the path of a shot? Draw a diagram to show how the path of a shot hit with a 9-iron might differ from that hit with a 3-iron. For a global connection, history lovers will enjoy reading about the Maori people of South America and New Zealand and the Polynesians of the Pacific Islands. They navigated the Pacific Ocean long before the invention of the compass and sextant by using the stars. In addition, they discovered the geometry and physics behind the wave patterns in the waters around the islands. They understood that parallel waves are reflected around islands in patterns, so taught their children to read those patterns with a mattang. Have students investigate the instrument and its method of navigation. Have kinesthetic and visual learners use everyday props to model vocabulary terms. A pencil pushed through a piece of paper can model the intersection of a line and a plane. Two pencils held in two different planes can represent two skew lines. Opening a notebook can model the intersection of two planes. Joining the ends of two straws with a twist tie can demonstrate all types of angles. Even a shoebox or cereal box can be used to illustrate parallel planes and/or intersecting segments.

*technology integration

Unit 2: Triangles and Their Relationships

Suggested Time Frame: 9 – 11 weeks

I. DESIRED RESULTS

Subject/Topic Areas:

Types of triangles
Proving triangles congruent
Using congruent triangles
Medians and altitudes of a triangle
Midsegment Theorem
Inequalities in a triangle
Indirect proof
Similar triangles
Proving triangles similar
Proportions and similar triangles
Dilations

Critical Vocabulary

Scalene triangle	Obtuse triangle	Acute triangle
Equiangular triangle	Equilateral triangle	Isosceles triangle
Vertex	Hypotenuse	Corollary
Legs of a triangle	Congruence	Right triangle
Coordinate proof	Base angles	Corresponding sides
Perpendicular bisector	Equidistant	Circumcenter
Angle bisector	Centroid	Orthocenter
Concurrent lines	Incenter	Midsegment
Indirect proof	Point of concurrency	Median
Ratio	Proportion	Means
Extremes	Scale factor	Reduction
Geometric mean	Similar polygon	Enlargement

I. DESIRED RESULTS (CONT.)

Established Goals– NJCCCS
(Including content area(s), technology, and life-skill standards/indicators)
Mathematics

- 4.2 (Geometry and Measurement) All students will develop spatial sense and the ability to use geometric properties, relationships, and measurement to model, describe and analyze phenomena.

- 4.3 (Patterns and Algebra) All students will represent and analyze relationships among variable quantities and solve problems involving patterns, functions, and algebraic concepts and processes.

- 4.4 (Data analysis, probability, and discrete mathematics) All students will develop an understanding of the concepts and techniques of data analysis, probability, and discrete mathematics, and will use them to model situations, solve problems, and analyze and draw appropriate inferences from data.

- 4.5 (Mathematical Processes) All students will use mathematical processes of problem-solving, communication, connections, reasoning, representations, and technology to solve problems and communicate mathematical ideas.

Language Arts Literacy

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Career Education and Consumer, Family, and Life Skills

- 9.1 (Career and Technical Education) All students will develop career awareness and planning, employability skills, and foundational knowledge necessary for success in the workplace.

- 9.2 (Consumer, Family, and Life Skills) All students will demonstrate critical life skills in order to be functional members of society.

Enduring Understandings: Students should understand that:	**Essential Questions:**
Mathematics is built on reason and always makes sense. Classifying helps to build networks of mathematical ideas. Precise language helps us express mathematical ideas and receive them. Mathematics can be used to solve problems outside of the mathematics classroom. An object in a plane can be oriented in an infinite number of ways while maintaining its size or shape.	What is used to prove a statement? How are solving and proving different? Why do we classify geometric objects? How does precise language help us express mathematical ideas? How can transformations be described mathematically? How are measurement and counting related?

Students Will Know and Be Able To:

- Classify triangles by their sides and angles.
- Find angle measures within triangles.
- Identify and prove congruent triangles and their corresponding parts.
- Write a coordinate proof by placing geometric figures on a coordinate plane.
- Use properties of perpendicular bisectors and angle bisectors to identify equal parts.
- Use properties of medians, altitudes, and midsegments of a triangle.
- Use the Triangle Inequality Theorem to determine the longest side or largest angle.
- Read, write, and interpret indirect proofs.
- Use proportionality theorems to calculate segment lengths.
- Use similar polygons to solve real-world problems.
- Use properties of dilations to solve real-world problems.

II. EVIDENCE OF STUDENT LEARNING

Formative Performance Task (A Formative Performance Task is presented to students at the beginning of the unit. It presents a problem that drives learning and may include several graded assessments).	**Summative Performance Task** (A Summative Performance Task is a *timed and graded test that assesses student learning*. It is generally a post-assessment administered at the end of a unit of study).
As a reporter, you are investigating a new bridge being built. For background on the story, you need to explain the types of engineers found on the site and the types of bridges available. Why are triangles an essential part of many bridges? Choose a human-made bridge and analyze its geometric concepts. Use the research to create a model of an original bridge. (See http://www.district87.org/staff/powelln/Geometry/Projects/Bridges/Default.htm.)* The city of Anaheim, California, is constructing a region called the Platinum Triangle. Investigate its background and site reasons for its construction. Design a similar region for another city in the United States. Create a map of the region on a coordinate grid. Then find its area and the lengths of its sides. Make your design congruent or similar to the Platinum Triangle. Prove that congruence or similarity. *	Use two different map websites to locate the same three cities. (For example, you can use Mapquest, Google maps, etc.) Print each map and highlight the triangle formed by the cities. Are the triangles congruent or similar? Prove your decision.* Investigate the pinwheel block pattern of quilting. Analyze the shapes and colors used. Identify the congruent and/or similar pieces. Then compare the pattern to a tessellation or to a parquet floor. How are they different? How are they the same? * As a graphic artist, you have designed a new postage stamp featuring the geometric shape of the triangle. Your design is currently 10.5 inches by 12 inches. Design the stamp and print it at that size. Then resize your stamp to the normal 7/8-inch by 1-inch size using a software program. Print the second image and compare lengths and angles to the original. Explain, using the theorems of the chapter, why the images are similar. Be sure your explanation includes precise vocabulary.*

Additional Graded/Formal Evidence of Student Learning and Progress

- Tests on proving congruent triangles; classifying triangles; finding points of concurrency in triangles; writing an indirect proof; proving triangles similar; solving proportions involving quadratic equations
- Readings on the congruence of shapes required in quilting; on the rigidity and strength of a triangle used in building a bridge
- Essays: What is meant by triangulation and how is it used to pinpoint the epicenter of an earthquake?
- Presentations: Examples of where congruent triangles and similar triangles are used in everyday life.
- Other: How do books entitled “Where’s Waldo?” use congruence?

Informal Assessments

(Informal assessments that allow students and teachers to check for understanding and monitor progress.)

- Pre-Assessments identifying triangles based on sides and angles; simplifying ratios; writing and solving proportions; identifying congruent shapes; simplifying fractions; simplifying radicals
- Portfolios: Collect diagrams showing congruent and similar triangles.
- Journals: Why are all congruent triangles also similar?
- Checklists: Have students create original checklists of theorems to use for proving triangles congruent or for proving triangles similar.
- Peer Review
- Informal Observations and Dialogues: Have students discuss the importance of congruence on modern assembly-line production.
- Think-Alouds: Have students compare the geometric mean and the arithmetic mean. How are they similar? How are they different?
- Examinations of Student Work
- Other

III. LEARNING PLAN

Suggested Activities *(Suggested learning activities that will allow students to successfully complete the assessment activities described in Section II).*	**Strategies for Differentiation** *(Differentiating content, process, and/or product, using variables of student readiness, interest, and learning style).* *Examples include:* *Readiness: small-group instruction, homework options, tiered assessments, compacting, multiple-entry points.* *Interest: Choices of books, homework options, explorations by interest and modes of expression (artistic, technological, written, oral, community service).* *Learning Style: Organizational options, working choice options, flexible environment, Multiple Intelligences options*
Provide twelve index cards to small groups of students. On separate cards, have them list the triangle segments (median, altitude, angle bisector, and perpendicular bisector), their points of concurrency (centroid, orthocenter, incenter, and circumcenter), and a diagram showing the triangle with its concurrent lines. Then have students take turns in finding matching triples: one triangle segment, one point of concurrency, and one diagram. Help students understand the concept of similarity by offering real-world situations. For example, have students compare the side ratios of a photograph and its negative. Or, show a figure on the overhead projector and compare its size to that on the original transparency. Or, bring in scale models of the Eiffel Tower and compare to the original building. For each example, emphasize the congruent angles, but proportional side lengths. Introduce scale drawings by having students enlarge their favorite cartoon character. They can use a grid on the original cartoon and enlarge it with a wider grid. Or, they can use a pantograph, an instrument designed to reduce or enlarge pictures by tracing. Try the web applet at http://www.ies.co.jp/math/java/geo/panta/panta.html.* Have students experience one of the uses of the centroid by constructing a mobile of triangles. Hang the triangles at their centroids to help balance the mobile. Julia Morgan, an American architect, designed many noteworthy buildings, including Hearst Castle in California. She often used triangular trusses made of redwood and exposed beams for strength and openness. Have student groups	Tiered textbook assignments offer differentiation on many levels. Individualize video clips from safari.npsd.us. * Kinesthetic learners can investigate the Triangle Inequality theorem by using straws and string. Have students cut straws to specific lengths and thread on a string to try to construct triangles. Straw lengths of 2-, 3-, and 6 inches will not form a triangle. Have students challenge each other to find side lengths that will and will not form triangles. Draw conclusions by combining data from the entire class. Visual learners can determine similar triangles by color-coding pairs of corresponding sides. Have students mark the corresponding angles first. Then use highlighters of different colors to mark pairs of corresponding sides. In India, geometry is used to expand Hindu temples in a way that reflects a person's growth. During each stage of development, a body grows but remains similar to the earlier form. The temples are built beginning with the altar, and then each stage of expansion adds to the structure. When temples are expanded, the expansion is called a gnomon. For a global connection, have history lovers explore this idea and relate it to similarity as used in geometry.

design an Internet scavenger hunt that highlights triangles used in architectural designs. This global connection might include the Triangle Building in Berlin, Germany; the Louvre Pyramid, the Eiffel Tower, Disney's Epcot Center Geodesic Dome, etc. Using Geometer's Sketchpad, have students investigate minimum conditions under which triangles are congruent. Have them analyze the least number of congruent sides and congruent angles needed to form congruent triangles. Consolidate class results and draw conclusions.* Have students interview a lawyer to discover how arguments are constructed to win a case on a point of law. What is the "given" information? What is the "proof"? What kinds of "justifications" are used for the conclusions? Ask the lawyer to give at least one example of an argument in detail. Have students discuss in detail those "triangles" that are impossible to create. For example, sides of 2, 3, and 6 will not create a triangle. Three angles measuring 30, 40, and 50 degrees will not form a triangle. Even an equilateral right triangle is impossible. Lead a class discussion for students to explain why these triangles cannot be formed.	Challenge students to explore the golden ratio by researching its discovery, history, and applications in art and architecture. Encourage students to use models and other visual aids to present their findings to the class.* Show visual learners exactly what is meant by the geometric mean: 16 is the geometric mean between 4 and 64 because of the geometric sequence: 1, 4, 16, 64, 256, …, where each term is multiplied by 4. Then use the formula to verify that $\sqrt{(4x64)} = \sqrt{256} = 16$. Draw an analogy to the arithmetic mean of 12 and 24. The arithmetic mean (average) is 18 because of the arithmetic sequence: 0, 6, 12, 18, 24, 30, ., where 6 is added to each term. For a non-equilateral triangle, the centroid, orthocenter, and circumcenter lie on a single line called the Euler line. This line is named for 18th century mathematician Leonhard Euler who is credited with the proof. Challenge students to study triangle centers in more depth by having them investigate the properties of the Euler line. Students who enjoy sailing may want to explore a rule called "doubling the angle on the bow." This method is used to find the distance between a boat and a landmark on shore. Have students present their findings to the class.

*technology integration

Unit 3: Quadrilaterals and Their Relationships

Suggested Time Frame: 9 – 11 weeks

I. DESIRED RESULTS

Subject/Topic Areas:

Polygons
Properties of parallelograms
Special quadrilaterals
Proving quadrilaterals are parallelograms
Transformations of polygons
Reflections
Rotations
Translations and vectors
Glide reflections and compositions

Critical Vocabulary:

Polygon	Square	Trapezoid
Regular polygon	Diagonal	Isosceles trapezoid
Rhombus	Rectangle	Convex
Concave	Parallelogram	Kite
Image	Preimage	Transformation
Line of symmetry	Rotation	Translation
Glide reflection	Composition	Isometry
Center of rotation	Reflection	Terminal point
Initial point	Vector	Hierarchy

I. DESIRED RESULTS (CONT.)

Established Goals– NJCCCS
(Including content area(s), technology, and life-skill standards/indicators)

Mathematics

- 4.2 (Geometry and Measurement) All students will develop spatial sense and the ability to use geometric properties, relationships, and measurement to model, describe and analyze phenomena.

- 4.3 (Patterns and Algebra) All students will represent and analyze relationships among variable quantities and solve problems involving patterns, functions, and algebraic concepts and processes.

- 4.5 (Mathematical Processes) All students will use mathematical processes of problem-solving, communication, connections, reasoning, representations, and technology to solve problems and communicate mathematical ideas.

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- 8.1 (Computer and Information Literacy) All students will use computer applications to gather and organize information and to solve problems.

- 8.2 (Technology Education) All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world as they relate to the individual, society, and their environment.

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- 9.2 (Consumer, Family, and Life Skills) All students will demonstrate critical life skills in order to be functional members of society.

Enduring Understandings: Students should understand that:	**Essential Questions:**
Mathematics is built on reason and always makes sense. Classifying helps to build networks of mathematical ideas. Precise language involving quadrilaterals helps us express mathematical ideas and receive them. Geometric figures and concepts can be used to represent real-world situations. Logical reasoning is used to draw conclusions from organized data.	How do you know when you have proven a statement? How does classifying of geometric objects make communication better? How does precise language help us express mathematical ideas? What are the benefits of drawing conclusions based on patterns? Why are minimum conditions helpful in forming conclusions?

Students Will Know and Be Able To:

- Identify, name, and describe polygons.
- Use the sum of the measures of the interior angles of a quadrilateral to solve problems.
- Use properties of quadrilaterals to solve real-world situations.
- Prove that a quadrilateral is a special type of quadrilateral, such as kite, trapezoid, or parallelogram.
- Identify special quadrilaterals based on limited data.
- Use various strategies to find the area of all types of quadrilaterals.
- Use transformations (translations, reflections, and rotations) in real-world situations.
- Identify relationships between reflections and line symmetry.
- Identify relationships between vectors and translations.

II. EVIDENCE OF STUDENT LEARNING

Formative Performance Task (A Formative Performance Task is presented to students at the beginning of the unit. It presents a problem that drives learning and may include several graded assessments).	**Summative Performance Task** (A Summative Performance Task is a *timed and graded test that assesses student learning*. It is generally a post-assessment administered at the end of a unit of study).
You have been commissioned to design a flag for the Junior Space Explorer program. In keeping with the theme of "Geometry in Space," your flag must contain evidence of angles, triangles, and quadrilaterals. The outside shape or perimeter of your flag must also reflect your understanding of symmetry. * Sir David Brewster invented the first tube kaleidoscope in 1816. How do kaleidoscopic images use reflections, translations, and rotations? Create your own kaleidoscope using household objects. Use geometric terms to explain how a kaleidoscope works.*	You have been hired to design desktop wallpaper for a new construction company specializing in geometric design. Design the desktop wallpaper for the company. Write an analysis on its content, paying special attention to the geometric shapes used and their transformations.* Quadrilateral linkages are used in mechanical design, robotics, the automotive industry, and toy making. Select one area and explain how the linkage works. Then use the properties of quadrilaterals to explain why it works. (For example, in cars, the trapezoidal linkage is used to turn each front wheel the right amount for a smooth turn.)

Additional Graded/Formal Evidence of Student Learning and Progress

- Tests on identifying and creating transformations; applying properties of special quadrilaterals to solve problems; proving quadrilaterals are kites, parallelograms, etc.
- Readings: How is geometry used in Islamic art?
- Essays: A "parallel rule" is a navigation tool used to plot ship routes on charts. Explain how and why this instrument works.
- Presentations: Present several photographs of Navajo rugs. Have students analyze the symmetry and transformations used in weaving the rugs.
- Other: Create a display showing the use of quadrilaterals in a parking lot or landscape design.

Formative Assessments

(Informal assessments that allow students and teachers to check for understanding and monitor progress.)

- Pre-Assessments on recognizing transformations by name; identifying special types of quadrilaterals; using a protractor to measure angles
- Portfolios: Have students collect their best rotation, translation, and reflection for their portfolios.

- Journals: How is a composition of two transformations similar to the composition of two functions?
- Checklists: Create individual checklists of properties for special quadrilaterals.
- Peer Review: Using the dilation command in Geometer's Sketchpad, have students create a design that involves repeated dilations. Print the design and color it. Have the class vote on the best design.*
- Informal Observations and Dialogues
- Think Alouds
- Examinations of Student Work: Using Geometer's Sketchpad, have students write their name. Then have them print three separate transformations of their name: a reflection over a horizontal line, a rotation about a point, and a diagonal translation. Display the results for other classes to see.*
- Other: A frieze pattern is a design that repeats itself along a straight line. These are often shown in wallpaper borders. Have students design their own frieze pattern and analyze it by using the vocabulary terms and concepts of the unit.

III. LEARNING PLAN

Suggested Activities *(Suggested learning activities that will allow students to successfully complete the assessment activities described in Section II).*	**Strategies for Differentiation** *(Differentiating content, process, and/or product, using variables of student readiness, interest, and learning style).* *Examples include:* *Readiness: small-group instruction, homework options, tiered assessments, compacting, multiple-entry points.* *Interest: Choices of books, homework options, explorations by interest and modes of expression (artistic, technological, written, oral, community service).* *Learning Style: Organizational options, working choice options, flexible environment, Multiple Intelligences options*
Invite a tailor to class to explain how a button spacer is used. The tool opens and closes, but the tips always remain equally spaced. What quadrilateral properties make this tool work correctly? For a global connection, have students explore the Japanese puzzle quilt and the way it uses congruent rhombuses. At first glance, Japanese puzzle quilts look like American quilts that have been sewn by hand. Working in pairs, have students plan, design, and create a Japanese puzzle quilt out of paper or fabric. Have students create their own quadrilateral hierarchy using Inspiration software. Print the organizers and display around the room. The same software can be used to develop proofs that show why specific quadrilaterals are parallelograms. In addition, the software can be used to draw Venn diagrams to show the relationships among special quadrilaterals.* Use TI-Navigator applications to help students identify specific quadrilaterals from four ordered pairs. See http://education.ti.com for activities.* With Geometer's Sketchpad or Cabri, have students create several parallelograms. Using those sketches, students can investigate properties dealing with parallel sides, opposite angles, diagonals, consecutive angles. Have students justify their conjectures.* Have small groups of students design and build simple kites. Encourage them to create kites in the shapes of special quadrilaterals. Lead a class discussion on which kites will fly and which will not. Allow time for students to fly their kites.	Tiered textbook assignments offer differentiation on many levels. Individualize video clips from safari.npsd.us. For those students who enjoy art, have them research the painting "Boy With Birds" by American artist David C. Driskell. The small, precise polygons in the painting give it a look of stained glass. Have them find other similar paintings to present to the class. Have artistic students explain the art style called Cubism, in which subjects are made of cubes and other geometric forms. For a global connection, have students explore this abstract art style through the works of Picasso and Gris of Spain and Cezanne, Braque, and Delaney of France. Athletic lovers will marvel at the use of quadrilaterals used in sports. Have them classify at least ten sports by the fields upon which they are played: rectangle, square, circle, etc. Lead a class discussion on how the lines are painted on the fields. How are the lines painted so that they are perpendicular or parallel? "Quad" can be used in words that are nouns, verbs, or adjectives. Have linguistic learners list as many words as possible that contain "quad." What do they have in common? Coin new words and have partners guess their meanings.

Nine Men's Morris is a game for two players that dates back to 1400 BC. The game board was one of seven found cut into the roof tiles of the temple in Karnak, Egypt. Evidence of the game has also been found in Ceylon, now Sri Lanka. For a global connection, have students investigate the background of the game and its rules of play. Using a compass and straightedge, have pairs of students construct the game board. Organize a tournament and have the entire class play the game. Have students explore flags of various countries of the world. Using rulers and protractors, have them identify special quadrilaterals within the flags. Encourage use of the words "fly" (length of the flag) and "hoist" (width of the flag). Invite a blend of geometry and physics in finding the centroid of a quadrilateral. Remind students that a centroid is the center of balance in a triangle, the point around which the weight of an object appears to be evenly distributed. Relate that data to a four-sided figure. Have students test their conjectures.	Have visual learners draw several different types of quadrilaterals. Extend the four sides, and then cut out four exterior angles, one at each vertex. Arrange the exterior angles so that they become adjacent angles with the same vertex. This model will show that the sum of the exterior angles will always be 360 degrees. Have kinesthetic learners use geoboards and rubber bands to construct each type of quadrilateral. Visual learners may enjoy the same activity using isometric dot paper. Encourage students to label each drawing and identify at least one property specific to that quadrilateral. The Great Wall of China is the only human-made object that can be seen by the astronauts walking on the moon. Most of the wall that remains is masonry built during the Ming Dynasty. For a global connection, have those students who enjoy history investigate the cross-section of the wall shaped like a trapezoid. Discuss the measurements of the wall that determine why the cross-section is a trapezoid.

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Unit 4: Circles and Measurement

Suggested Time Frame: 8 – 10 weeks

I. DESIRED RESULTS

Subject/Topic Areas: (if applicable)

Angles and segments within circles
Angle measures in polygons
Areas of regular polygons
Circumference and arc length
Areas of circles and sectors
Geometric probabilities
Surface area of three-dimensional shapes
Volume of three-dimensional shapes

Critical Vocabulary (if applicable)

Concentric circles
Common tangent
Inscribed angle
Chord
Inscribed polygon
Arc length
Geometric probability
Right cone
Lateral faces
Surface area
Major arc
Semicircle
Point of tangency
Tangent
Minor arc
Apothem
Polyhedron
Prism
Pyramid
Similar Solids
Minor arc
Secant segment
Central angle
Intercepted arc
Circumscribed circle
Sector
Cylinder
Sphere
Great circle
Platonic solids

I. DESIRED RESULTS (CONT.)

Established Goals– NJCCCS
(Including content area(s), technology, and life-skill standards/indicators)
Mathematics

- 4.1 (Number and Numerical Operations) All students will develop number sense and will perform standard numerical operations and estimations on all types of numbers in a variety of ways.

- 4.2 (Geometry and Measurement) All students will develop spatial sense and the ability to use geometric properties, relationships, and measurement to model, describe and analyze phenomena.

- 4.4 (Data analysis, probability, and discrete mathematics) All students will develop an understanding of the concepts and techniques of data analysis, probability, and discrete mathematics, and will use them to model situations, solve problems, and analyze and draw appropriate inferences from data.

- 4.5 (Mathematical Processes) All students will use mathematical processes of problem-solving, communication, connections, reasoning, representations, and technology to solve problems and communicate mathematical ideas.

Language Arts Literacy

- 3.1 (Reading) All students will understand and apply the knowledge of sounds, letters, and word in written English to become independent and fluent readers, and will read a variety of materials and texts with fluency and comprehension.

- 3.2 (Writing) All students will write in clear, concise, organized language that varies in content and form for different audiences and purposes.

- 3.3 (Speaking) All students will speak in clear, concise, organized language that varies in content and form for different audiences and purposes.

- 3.4 (Listening) All students will listen actively to Information from a variety of sources in a variety of situations.

- 3.5 (Viewing and Media Literacy) All students will access, view, evaluate, and respond to print, nonprint, and electronic texts and resources.

Technological Literacy

- 8.1 (Computer and Information Literacy) All students will use computer applications to gather and organize information and to solve problems.

- 8.2 (Technology Education) All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world as they relate to the individual, society, and their environment.

Career Education and Consumer, Family, and Life Skills

- 9.1 (Career and Technical Education) All students will develop career awareness and planning, employability skills, and foundational knowledge necessary for success in the workplace.

- 9.2 (Consumer, Family, and Life Skills) All students will demonstrate critical life skills in order to be functional members of society.

Enduring Understandings: Students should understand that:	**Essential Questions:**
Mathematics can be used to solve problems outside of the mathematics classroom. Geometric figures can be used to represent real-world situations. Two- and three-dimensional objects can be described, classified, and analyzed by their attributes. Linear measure, area, and volume are fundamentally different, but may be related to one another in ways that permit calculation of one given the other.	How does classifying of geometric objects make communication better? How does precise language help us express mathematical ideas? How can you determine similarities and differences that help you make generalizations? How are measurement and counting related? How does what we measure affect how we measure?

Students Will Know and Be Able To:

- Identify segments, angles, and lines related to circles.
- Use properties of inscribed angles, arcs, and chords to solve problems.
- Calculate angle measurements, chords, and other segments within a circle.
- Calculate measures of interior and exterior angles of polygons.
- Find areas of regular polygons.
- Compare perimeters and areas of similar figures.
- Find circumference and arc lengths of a circle.
- Find geometric probabilities.
- Use properties of polyhedra.
- Find the surface area of spheres, cylinders, prisms, pyramids, and cones.
- Find the volume of spheres, prisms, cylinders, pyramids, and cones.

II. EVIDENCE OF STUDENT LEARNING

Formative Performance Task (A Formative Performance Task is presented to students at the beginning of the unit. It presents a problem that drives learning and may include several graded assessments).	**Summative Performance Task** (A Summative Performance Task is a *timed and graded test that assesses student learning*. It is generally a post-assessment administered at the end of a unit of study).
A landscaping firm has hired you to design a circular pond for a client. The pond requires at least two walkways across the pond. Sketch the pond and its walkways, providing as many lengths and angle measurements as possible for the blueprints. The track team has asked you to design a four-lane oval track with straight sides and semicircular ends. The design is to include the start and finish lines so that the race can be run fairly in all four lanes. The lanes are to be one meter wide. An explanation is to accompany the design to describe how the radius, lane width, and sides influenced the design. The word "mandala" is from the classical Indian language of Sanskrit. Loosely translated to mean "circle," a mandala is a complex circular design arranged in rings that radiate from the center. Research this art form and create your own mandala. For a global connection, make a rough draft with compass and straightedge. Then use Geometer's Sketchpad or other software to complete the design. Describe your mandala using the vocabulary and theorems of the unit.* Enter the Hot Air Balloon Race by designing your own balloon using polygonal panels. Build a scale model of your balloon. Calculate its surface area and volume. What will be the perimeter of the balloon at its widest?	Calculate the costs of renovating the walls and floor of your bedroom. In chart form, show the dimensions of your room, the costs of wallpapering and/or painting, and carpeting. Estimate the total cost using prices from the Internet.* As managing supervisor of design packaging for a large jewelry firm, you have been asked to create the box for an award-winning diamond pendant. It requires a unique design with a maximum volume of twelve cubic inches. Use geometry software to sketch the net for the box. Label all essential dimensions. Show calculations for its volume. As a Great Adventure enthusiast, you have been asked to design a new Ferris wheel. Describe your new ride by using as many vocabulary terms, angle measures, and segment lengths as possible. Cite the theorems you used. Complete the design using technology.* The residents of your hometown have decided to honor you by building a 100-ft solid-gold statue in the center of town. Draw a sketch of the statue. Estimate its weight and cost. Your community is sponsoring a vegetable garden. You need to fence in a rectangular, semicircular, or trapezoidal garden using the wall of a building and 10 meters of fencing for the remaining sides. What dimension(s) will give you the maximum area for the garden? Draw a diagram and explain how you arrived at your answer.

Additional Graded/Formal Evidence of Student Learning and Progress

- Tests on angle measurements within circles; segment measurements within circles; areas of regular polygons; surface areas of solid shapes; volumes of solid shapes
- Readings: Have students read Gulliver's Travels by Jonathan Swift and create their own problems to compare length, area, and volume. For example, if the Lilliputian average height was 1/12 that of Gulliver's height, how many Lilliputian coats could be made from the material in one of Gulliver's coats?
- Essays: What role does three-dimensional geometry play in the structure of molecules? Research the atomic arrangement of carbon in graphite and in diamonds. Carbon atoms can also bond into large molecules named fullerenes, after Buckminster Fuller. These are called buckyballs.
- Presentations: For a global connection, encourage students to check out the polygonal shapes in the Ramat Polin housing complex in Jerusalem, Israel, and present their findings to the class.
- Other: Have pairs of students work together to formulate the relationship between lateral faces, edges, and vertices of polyhedra. Have them write their discovery as a formula.

Informal Assessments

(Informal assessments that allow students and teachers to check for understanding and monitor progress.)

- Pre-Assessments on simple area and volume formulas; identification of solid shapes; vocabulary terms of a circle.
- Portfolios
- Journals: Have students write about their interpretation of Cavalieri's Principle.
- Checklists: Create checklists involving the use of the formulas for this unit.
- Peer Review: Have students check each other's work for the correct formula, substitution, and final answer.
- Informal Observations and Dialogues
- Think-Alouds: Have students discuss the meaning of "height" as it pertains to triangles, trapezoids, and parallelograms. How does "height" differ from "base?"
- Examinations of Student Work
- Other: For a global connection, have small groups of students investigate the following puzzle by Piet Hein, a Danish mathematician: What are all the possible nonconvex solids that can be created by joining four or fewer cubes face-to-face? These seven solids can then be put together to form the Soma Cube.

III. LEARNING PLAN

Suggested Activities *(Suggested learning activities that will allow students to successfully complete the assessment activities described in Section II).*	**Strategies for Differentiation** *(Differentiating content, process, and/or product, using variables of student readiness, interest, and learning style).* *Examples include:* *Readiness: small-group instruction, homework options, tiered assessments, compacting, multiple-entry points.* *Interest: Choices of books, homework options, explorations by interest and modes of expression (artistic, technological, written, oral, community service).* *Learning Style: Organizational options, working choice options, flexible environment, Multiple Intelligences options*
Have students use geoboards to investigate the area of similar figures. If the sides are doubled, does the area double? Have students investigate neighborhood prices for personal, medium, and large pizzas. Are the prices proportional? Which is the best buy? Explore the world champion string collector, J. C. Payne. Find the weight and circumference of the ball of string he collected. Have students work backwards to determine the diameter of the ball of string and its surface area. Use Geometer's Sketchpad or Cabri to explore the lengths of tangent segments, arc measures for central and inscribed angles, properties of chords, or lengths of intersecting tangents and chords. Have students write generalizations on the board. Then have the class decide which statements are always valid. * For a global connection, have students research measurements of the Great Pyramid at Giza, Egypt. Compare that structure to the pyramid at Cholula, Mexico. Have students find the lateral area, its footprint, and the volume of each pyramid.* A square which can be dissected into a number of smaller squares with no two equals is called a perfect square dissection (or a squared square). Have students investigate and create a "squared square." * Native American geometry is a physical, proportional geometry that originates from the simple circle. Have students visit http://www.earthmeasure.com/index_earth.html to investigate the background and designs.*	Tiered textbook assignments offer differentiation on many levels. Individualize video clips from safari.npsd.us. History lovers will enjoy President Garfield's proof of the Pythagorean Theorem. The proof involves triangles and trapezoids. Have pairs of students present the proof to the class. Have visual learners unfold a cereal box and recreate the pattern (net) on graph paper. Use a group effort to find the lateral area and surface area of the package. Extend the activity to include cylindrical oatmeal boxes. Challenge students to create a net for a sphere. Encourage them to research various kinds of maps used for our planet Earth. Kinesthetic learners will enjoy forming geometric solids from their nets. Search the Internet for the nets. Help students form the solid shapes and create a class mobile. Then have students identify specific names for the shapes.* For students who love to cook, have them design a special cake to celebrate the latest sports event. It must have at least two layers and be frosted with icing. Design and sketch the cake. Include the dimensions of the layers and the amount of frosting needed.

Global Positioning System (GPS) satellites orbit about 11,000 miles above Earth. Why is more than one satellite required to service Earth? Use TI-Navigator to send students a file of questions about circles and angle relationships. See http://education.ti.com for activities.* "If a diameter bisects a chord, then the diameter is perpendicular to the chord." Initiate class discussion by asking if students think that the statement is true. (It is false because the chord mentioned could be another diameter, in which case the two segments need not be perpendicular). For a global connection, have students research the AIDS Memorial quilt, estimated to weigh about 54 tons. Each 3-foot by 6-foot panel is the size of a human grave. The panels are then grouped and assembled into 12-foot by 12-foot sections, called "blocks". Each block requires about one cubic foot of storage. Have students create area and volume problems from their research. *	Auditory learners will benefit from songs or stories that help students recite area and volume formulas. Encourage original creations. Have kinesthetic learners trace coffee cans or drinking cups to form circles. Using a compass and straight edge, have students locate the center of each circle by constructing two perpendicular bisectors. Have visual learners use Inspiration software to construct a graphic organizer of the theorems involving circles. * Students who enjoy athletics can compare the volumes of several spheres used in sports: baseball, basketball, softball, bowling ball, golf ball, etc. Have them create a chart to show the radius, surface area, and volume of each ball.* Encourage visual learners to use colored pencils or markers to highlight intercepted arcs of inscribed and central angles. This will draw attention to the appropriate part of the circle. Another method is to clarify diagrams by redrawing each inscribed angle in a separate circle. Kinesthetic learners may enjoy the use of flashcards to match the formulas of the unit with the corresponding plane or solid figures.

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