Geometry Unit 1: Foundations of Geometry (Gr. 9 - 11)

Content Area: **Mathematics**
Course(s): **Geometry**
Time Period: **1st Marking Period**
Length: **6 Weeks**
Status: **Published**

Unit Overview

As this unit begins, students will strengthen their understanding of basic geometric terminology, point, line, plane, and angle relationships. Following this, students will begin to study logical reasoning as they explore patterns, conditional, and biconditional statements, as well as consider truth values and provide counterexamples as appropriate. Next, students will carefully define parallel and perpendicular lines, and will review and solve problems based on the relationships that exist among them. Finally, students will review basic triangle definitions and properties, single triangle inequality theorems, the Pythagorean Theorem, and basic area formulas, solving problems related to each topic.

Transfer

Students will be able to independently use their learning to...

- Relate geometric terminology to real-world settings.
- Describe the relationships between basic geometric figures.
- Solve real-life and mathematical problems involving line and angle relationships, triangles, and area.
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations.
- Use available information to reach logical conclusions and construct logical arguments.
- Critique the reasoning of others, providing counterexamples as appropriate.

Meaning

Understandings

Students will understand that...

- The terms *point, line,* and *plane* are undefined terms upon which all other geometric concepts are based.
- The relationships that exist between specific angle pairs are used in solving for unknown measures.
- Mathematical statements are either true or false.
- Statements can be proven false with one counterexample.
- The phrase "if and only if" implies that both a conditional statement and its converse are true.
- Specific angle relationships can be used to distinguish between parallel and non-parallel lines. Conversely, when parallel lines are intersected by a transversal, unique relationships exist between

specific angle pairs.

Essential Questions

Students will keep considering...

- How can geometric figures and their properties be described through careful use of geometric language?
- How can the unique properties of geometric figures be used to determine new information?
- How can available information and logical reasoning be used to develop and prove conjectures?
- When can mathematical properties effectively be written as biconditional statements?
- What relationships exist between the sides and/or angles of a triangle?

Application of Knowledge and Skill

Students will know...

- The meanings of basic geometric terminology and symbols.
- Postulates describing the relationships between points, lines, and planes.
- That bisectors divide angles or segments into two congruent parts.
- The relationships between linear pairs, vertical, supplementary, and complementary angles.
- What is meant by writing conjectures.
- That conditional statements and their converses contain both a hypothesis and a conclusion.
- That biconditional statements are used to combine conditional statements and their converses when both statements are true.
- That counterexamples can be used to disprove statements.
- That most rules in geometry come in the form of theorems, which are statements that have been proven.
- Which angle pairs are congruent and which are supplementary when parallel lines are intersected by a transversal.
- That specific angle relationships formed when two lines are interesected by a transversal can be used to show that two lines are parallel.
- The properties of perpendicular lines.

Students will be skilled at...

- Using geometric symbols and terminology correctly.

- Using given information and diagrams to make accurate conclusions about points, lines, and planes.
- Using the segment and angle addition postulates to write accurate equations and solve for unknowns.
- Using the relationships between linear pairs, vertical. supplementary, complementary, and bisected angles to write accurate equations and solve for unknowns.
- Making formal geometric constructions to copy a segment, copy an angle, bisect a segment, bisect an angle, construct perpendicular lines, including the perpendicular bisector of a line segment, and construct a line parallel to a given line through a point not on the line.
- Creating and using examples to write valid conjectures.
- Reading and interpreting conditional and biconditional statements.
- Judging the validity of statements and writing counterexamples to disprove them as appropriate.
- Writing simple geometric proofs involving basic angle relationships, parallel and perpendicular lines.
- Solving for unknowns when parallel lines and a transversal are given, writing and using equations as needed.
- Using known angle relationships to determine when two lines are parallel or perpendicular.

Academic Vocabulary

- acute angle
- acute triangle
- adjacent angle
- alternate exterior angles
- alternate interior angles
- angle
- angle bisector
- area
- base
- between
- biconditional statement
- bisect
- collinear
- complementary angles
- conclusion
- conditional statement
- congruent
- congruent angles
- congruent segments
- conjecture
- converse
- coplanar
- corresponding angles

- counterexample
- deductive reasoning
- definition
- degree
- distance
- distance from a point to a line
- endpoint
- equiangular triangle
- equilateral triangle
- exterior of an angle
- hypotenuse
- hypothesis
- inductive reasoning
- interior of an angle
- isosceles triangle
- justify
- length
- line
- linear pair
- measure
- midpoint
- obtuse angle
- obtuse triangle
- opposite rays
- parallel lines
- parallel planes
- parallelogram
- perpendicular bisector
- perpendicular lines
- plane
- point
- polygon
- postulate
- quadrilateral
- ray
- rectangle
- rhombus
- right angle
- right triangle

- same-side exterior angles
- same-side interior angles
- scalene triangle
- segment
- segment bisector
- skew lines
- square
- straight angle
- supplementary angles
- theorem
- transversal
- trapezoid
- triangle
- undefined term
- vertex
- vertical angles

Learning Goal 1.1

Students will use the undefined notions of point, line, plane, and distance along a line to develop definitions for angles, line segments, and rays, and will create and use sketches to solve problems involving angle and segment measures.

Daily Target 1.1.1 (Level of Difficulty: Retrieval, DOK: 1- Recall)

SWBAT identify, name, and sketch points, lines, segments, rays, and planes, as well as explain the basic relationships that exist among them.

MA.G-CO.A.1	Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
MA.K-12.6	Attend to precision.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

Daily Target 1.1.2 (Level of Difficulty: Comprehension, DOK: 2 - Skill)

SWBAT calculate segment lengths and angle measures, as well as use the Segment and Angle Addition Postulates to solve for unknown measurements.

MA.G-CO.A.1	Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.7	Look for and make use of structure.

Daily Target 1.1.3 (Level of Difficulty: Analysis , DOK: 3 - Strategic Thinking)

SWBAT identify adjacent, vertical, complementary, and supplementary angles, and will be able to use given information to solve for unknowns in related problems.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

Learning Goal 1.2

Students will be able to identify patterns, write and evaluate conjectures in the form of conditional and biconditional statements, and provide counterexamples as appropriate.

Daily Target 1.2.1 (Level of Difficulty: Analysis, DOK: 3 - Strategic Thinking)

SWBAT develop examples to illustrate mathematical properties, identify patterns and use inductive reasoning to make conjectures.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.K-12.8	Look for and express regularity in repeated reasoning.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.9-10.CCSS.ELA-Literacy.WHST.9-10.1e	Provide a concluding statement or section that follows from or supports the argument presented.

Daily Target 1.2.2 (Level of Difficulty: Analysis, DOK: 3 - Strategic Thinking)

SWBAT identify, write, and analyze the truth values of conditional statements and their converses, giving counterexamples to disprove conjectures as appropriate.

MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.9-10.CCSS.ELA-Literacy.CCRA.R.4	Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

Daily Target 1.2.3 (Level of Difficulty: Analysis, DOK: 3 - Strategic Thinking)

SWBAT write and analyze biconditional statements.

MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.9-10.CCSS.ELA-Literacy.CCRA.R.4	Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

Learning Goal 1.3

Students will know and be able to apply theorems involving parallel lines, transversals, and perpendicular lines.

Daily Target 1.3.1 (Level of Difficulty: Retrieval, DOK: 1 - Recall)

SWBAT define parallel and perpendicular lines, as well as describe and identify each of the following:

- parallel planes
- skew lines
- transversals
- corresponding angles
- alternate interior angles
- alternate exterior angles

- same-side interior angles
- same-side exterior angles

Defining Parallel Lines: https://www.illustrativemathematics.org/content-standards/HSG/CO/A/1/tasks/1543

Defining Perpendicular Lines: https://www.illustrativemathematics.org/content-standards/HSG/CO/A/1/tasks/1544

MA.G-CO.A.1	Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
MA.K-12.6	Attend to precision.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

Daily Target 1.3.2 (Level of Difficulty: Knowledge Utilization, DOK: 4 - Extended Thinking)

SWBAT use theorems involving the angles formed by parallel lines and a transversals to justify conclusions and solve for unknown measures. Theorems should include:

- When a transversal crosses parallel lines, corresponding angles are congruent.
- When a transversal crosses parallel lines, alternate interior angles are congruent.
- When a transversal crosses parallel lines, alternate exterior angles are congruent.
- When a transversal crosses parallel lines, same-side interior angles are supplementary.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.G-CO.C.9	Prove theorems about lines and angles.
MA.K-12.8	Look for and express regularity in repeated reasoning.

Daily Target 1.3.3 (Level of Difficulty: Knowledge Utilization, DOK: 4 - Extended Thinking)

SWBAT use angles formed when a transversal intersects coplanar lines to determine whether given lines are parallel, as well as use these relationships to solve for unknown measures. Theorems should include:

- If two coplanar lines are cut by a transversal so that alternate interior angles are congruent, then the two lines are parallel.
- If two coplanar lines are cut by a transversal so that alternate exterior angles are congruent, then the two lines are parallel.

- If two coplanar lines are cut by a transversal so that same-side interior angles are supplementary, then the two lines are parallel.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.G-CO.C.9	Prove theorems about lines and angles.
MA.K-12.8	Look for and express regularity in repeated reasoning.

Daily Target 1.3.4 (Level of Difficulty: Knowledge Utilization, DOK: 4 - Extended Thinking)

SWBAT use theorems relating perpendicular lines to reach and justify conclusions, and write equations to solve for unknowns.

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.G-CO.C.9	Prove theorems about lines and angles.

Daily Target 1.3.5 (Level of Difficulty: 4 - Extended Thinking)

SWBAT use a diagram and given information to construct a simple two-column deductive proof relating lines and angles. (Including proof that vertical angles are congruent.)

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.

Learning Goal 1.4

SWBAT solve problems involving triangles and areas of polygons.

Daily Target 1.4.1 (Level of Difficulty: Retrieval, DOK: 1 - Recall)

SWBAT classify triangles by their angles measures and side lengths.

MA.K-12.6	Attend to precision.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

Daily Target 1.4.2 (Level of Difficulty: Comprehension, DOK: 2 - Skill)

SWBAT apply properties of triangles to solve for unknown measures, including problems involving:

- Interior angles
- Exterior angles
- Isosceles triangles
- Equilateral triangles

MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.G-CO.C.10	Prove theorems about triangles.

Daily Target 1.4.3 (Level of Difficulty: Analysis, DOK: 3 - Strategic Thinking)

SWBAT justify and apply triangle inequality theorems to compare side lengths and angle measures in triangles, and to determine whether it is possible to create a triangle with given side lengths.

- If two sides of a triangle are not congruent, then the larger angle is opposite the longer side.
- If two angles of a triangle are not congruent, then the longer side is opposite the larger angle.
- The sum of two side lengths of a triangle must be greater than the third side length.
- The measure of an exterior angle of a triangle is greater than the measure of either of its remote interior angles.

MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.G-CO.C.10	Prove theorems about triangles.

Daily Target 1.4.4 (Level of Difficulty: Analysis, DOK: 3 - Strategic Thinking)

SWBAT apply the Pythagorean Theorem to determine unknown segment lengths in right triangles and in real-world problems.

MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.G-SRT.C.8	Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Daily Target 1.4.5 (Level of Difficulty: Comprehension, DOK: 2 - Skill)

Given their side lengths, SWBAT use the Converses to The Pythagorean Theorem to classify triangles as acute, right, obtuse, or not possible.

MA.K-12.4	Model with mathematics.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.G-SRT.C.8	Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Daily Target 1.4.6 (Level of Difficulty: Comprehension, DOK: 2 - Skill)

SWBAT calculate the area and perimeter of each of the figures listed below. Given the area and one or more measurements of each of the figures listed, SWBAT calculate unknown measurements.

- Triangles
- Parallelograms (including rectangles, rhombi, and squares)
- Trapezoids

MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.G-MG.A.1	Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).
MA.G-MG.A.2	Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

21st Century Life and Careers

CRP.K-12.CRP1	Act as a responsible and contributing citizen and employee.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP9	Model integrity, ethical leadership and effective management.
CRP.K-12.CRP11	Use technology to enhance productivity.
CAEP.9.2.12.C.1	Review career goals and determine steps necessary for attainment.

Summative Assessment

- Projects
- Quizzes

- Student Portfolios
- Tests
- Unit 1 Assessment (Common Assessment)

Formative Assessment and Performance Opportunities

- "I have...Who has..." Review Activities
- Academic Games
- Carousel Activities
- Class Discussions
- Classwork
- Closure Activities
- Concept Sorting Activities
- Desmos Activities
- Do Nows
- Edulastic
- Exit Tickets
- Four Corners Activities
- Graphic Organizers
- Homework
- Kahoot! Games
- Placemat Activities
- Question-All-Writes
- Quiz-Quiz-Trade Activities
- Station Activities
- Student Interviews
- Student Response Systems
- Student Self-Ratings
- Teacher Observation
- Teacher Questioning
- Think, Pair, Share Discussions
- Thumbs Up/Down
- Whip Around
- Whiteboard Use

Accommodations and Modifications

- 504 Accomodations
- Challenge Problems

- IEP Modifications
- Learning Centers/Stations
- Leveled Practice Opportunities
- Scaffolding Questions
- Small Group Instruction
- Student Companion Website Resources
- Technology
- Use of Manipulatives (Paper Strips, Exploragons, etc.)

Unit Resources

- Textbook: Geometry, Common Core Ed. (Holt McDougal, 2012)
- Textbook Resource Kit & Companion Website: https://my.hrw.com/
- Geometer's Sketchpad
- Kuta Software

Additional Websites:

- Dan Meyer's 3-Act Math Tasks: https://docs.google.com/spreadsheet/pub?key=0AjIqyKM9d7ZYdEhtR3BJMmdBWnM2YWxWYVM1UWowTEE&output=htmlG
- Engage NY: Geometry Lesson Notes & Handouts: https://www.engageny.org/resource/high-school-geometry
- Geometry Teacher Mike Patterson's Common Core Teaching Notes: http://www.geometrycommoncore.com/
- Khan Academy: https://www.khanacademy.org/
- NCTM Illuminations Website: Resources for Teaching Math: http://illuminations.nctm.org/Default.aspx
- PARCC Educator Resources: http://www.parcconline.org/for-educators
- The Geometer's Sketchpad Resource Center: http://www.dynamicgeometry.com/